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CONTENTS

"THE ASCENT OF SAP"

George J. Peirce

Many of the experiments designed to throw light on the question of how water goes up a tree are justly criticised because they involve wounding, or even amputation, as a part of the method of experiment. I wish, therefore, in this brief note, to describe the behavior of intact plants which I subjected to certain influences, and to state the inferences which I draw from the evident effects.

We may conceive the water in the body of any plant (or animal), whether terrestrial or aquatic, whether tree or shrub or herb, as forming a continuous mass, permeating all the walls and other solid parts of the plant body, as well as forming an indispensable constituent of the living cells and of the living protoplasm. This wet mass extends from root tip to stem tip. Some of this water is free to move, moves easily at some or all times, as all know when a plant bleeds; while other parts of the water mass are held tightly, as indicated by the slow drying of lumber. Some of the water may exist as liquid, quite filling the wood elements, as in vine and maple in the spring; some of it exists as a film lining the wet walls of the conducting elements of the wood, as in trees, shrubs, vines, and herbs in mid-summer; some of it exists as water vapor filling the cavities of the ducts and tracheids of the wood. The mass of water may be subjected to push or pressure in various parts of the system, and hence the expression root-pressure, which, however, may develop in stems and branches also. And in other parts of the water mass deficit, suction, or pull may prevail. Thus during a warm sunny day, with a breeze stirring the warm dry air, water is flying off, evaporating, from the leaves, as from all wet masses and the plant is said to be transpiring. As water flies off, molecule by molecule, from the wet interior of a leaf into the dryer air, the water mass not only diminishes but is subjected to the pull of each departing molecule. The total pull of all the molecules flying off into the air is called the suction force of the leaves, and it is great or small or *nil* according to the rate of water loss from the leaves by evaporation.

When one wounds a leafy branch or plant, one breaks into and through the continuous water mass just described. If there is water pressure in the mass, the wound will bleed. If there is water deficit, by reason of water loss from the leaves, the wound will suck in air. If the cut be made under water, the sucking of air will be prevented, but the tensions in the water mass become changed immediately, and the distribution of water—liquid mass, film, and vapor—may be profoundly and instantly altered. The condition is at least very unnatural.

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But if one experiment upon whole plants, with their roots undisturbed in the soil, their stems and branches in normal position in the air, their foliage spread out in the sunshine, one will employ the full suction force of the leaves, the conducting tissues of wood and bark will be unhurt and their contents unaltered, and the roots will continue to absorb water according to moisture, temperature, etc. as before. These were precisely the conditions which I found and used in experiments upon leafy branches, stems, and petioles of castor bean growing out of doors near my laboratory, and upon the leafy branches of a buckeye tree growing between the well watered grassy fairway of the Stanford Golf Course and San Francisquito Creek.

The experiments consisted in the application of a cooling or warming agent to a zone of stem, branch, or petiole. This was accomplished by adjusting waterproofed paper cups of one design or another to the stem, branch, or petiole, and pouring the cooling or warming agent into such cups to the depth of a centimeter or two. The agents were liquids, in order to secure the most complete contact possible with the plant. They were liquid air, producing a minimum temperature of $-192°$; salt and ice ($-12° \pm$); and water with floating ice (0.0° C.). In a few experiments I used warm water of a temperature of 70° C. The details both of experiments and of results will be reported elsewhere. Suffice it to say here that the results were definite. The cooling of a part of a stem, branch, or petiole, through which sap is moving upward toward the leaves or leaf, is promptly followed by a slowing or checking of the sap stream through the chilled zone, as shown by the wilting of the leaves or leaf. Furthermore, longitudinal splitting of the cooled stem, branch, or petiole reveals to the eye that it has had its water drawn away; the cut surface is relatively dry in the cooled zone and especially immediately above, even when the parts further up and those below the chilled zone may contain enough water to show on the freshly cut surface, if not to bleed.

The wilting and other effects are more or less pronounced according to the degree of cooling, ice water on a cool day having little wilting effect, as shown by the slight wilting of the leaves; ice water on a warm day is more effective; salt and ice are followed by prompt and evident wilting; and liquid air, in contact with a zone about 1 cm. broad and for less than one half minute, induces marked and immediate wilting. Exposure to liquid air for long enough to freeze stem or petiole solid, though for a few moments only, results in the death of the leaf or leaves.

Previous experiments have shown that sap ascends mainly through the wood. It does so as masses or films or vapor.[1] It

[1] Peirce, G. J. Observations on Sap Hydraulics. Am. Journ. Bot., 21: 211–227, 1934.

is part of that continuous mass of water which is an indispensable constituent of every living organism. When molecules of water fly off into the air (evaporate), they pull other molecules after them; their passage from the liquid state to that of vapor exerts a pull, whether this take place at the surface of a cell in a leaf or at any other point in the system, in a vessel or tracheid in the wood. This pull, multiplied as many millions of times as there are molecules, plus the energy of motion of the water molecules themselves in the mass, is one means by which water goes up a tree.

The temperature of the plant and of its parts; the spread of the evaporating surface; the absorbing system; those living cells which are along the way between roots and leaves; the structure of the wood in roots, stems, branches, petioles, blades; these all share in "the ascent of sap," the movement of water, from roots to leaves.

The temperature determines the relative proportions of liquid and vaporous water. Since vapor moves much more readily and much more rapidly than liquid water, lowering the temperature by chilling the stem, branch, or petiole and condensing some of the vapor slows the sap stream and induces wilting. Conversely, warming the part increases the proportion of vapor and hastens the water movement. The spread of the evaporating surface determines the amount of suction applied to the conducting system, but in the warmer half of the year there is a spread of foliage far greater than in the colder. Hence mobile, vaporous water and high water loss from extended foliage are synchronous: and conversely, bare branches and cold weather, when water moves slowly, are also synchronous. Furthermore, all evergreens living in alternately warm and cold areas, have leaves which reduce evaporation to a relatively low rate, *e. g.*, live oak, pines, etc. The absorbing system also is greatly influenced by temperature, for in cold soil it absorbs much more slowly than in warm soil.[2] Conversely, if the soil is warm and the air cold, absorption tends to exceed water loss, and the plant fills with water. This is illustrated by the run of maple sap and by the bleeding of grape vines, in the spring. But we may have all of these features, and suitable wood anatomy in roots, stems, and leaves, and unless the living cells throughout the plant are in health, the system will not be maintained, and the ascent of sap will not be normal.

Stanford University,
August, 1934.

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[2] Peirce *l.c.* p. 217–8.

STUDIES UPON THE TAXONOMY OF THE MADINAE

DAVID D. KECK

In the course of several seasons' work upon the taxonomy of the Madinae, the "tarweed" subtribe of Compositae, the following records, among others, have been brought to light. Because the final monographic treatment of this group, which is to cover the results of garden experiments, as well as the cytologic, genetic and systematic aspects, will not be completed for a number of months, it is desirable to record nomenclatorial changes and describe certain groups at this time in order that the proper names for these entities may be generally available. Full citation of specimens and synonymy is reserved for the later treatment.

It should be brought to attention that the recent paper of Dr. D. A. Johansen on "Cytology of the Tribe Madinae, Family Compositae" [1] gave informal reference to several of the names that are taken up here. The present writer supplied Johansen with all the appellations used. Inasmuch as these were employed as common names, being placed in quotation marks, in a non-taxonomic paper, by one who not only pointed out their tentative nature but also disclaimed all intent of making nomenclatorial changes, he and we do not intend to credit them with any nomenclatorial standing.

MADIA

The two largest species of Madia are exceedingly polymorphous and are composed of the following subspecies:

MADIA SATIVA Molina subsp. **typica** nom. nov.—*M. sativa* Mol. Sagg. Chile ed. 1, 136, 1782.

MADIA SATIVA subsp. CAPITATA (Nutt.) Piper, Contr. U. S. Nat. Herb. 11: 576, 1906.

MADIA SATIVA subsp. **dissitiflora** (Nutt.) comb. nov.—*Madorella dissitiflora* Nutt. Trans. Am. Phil. Soc. II, 7: 387, 1841. *Madia dissitiflora* Torr. et Gray, Fl. N. Am. 2: 405, 1843. *M. sativa* var. *dissitiflora* Gray, Proc. Am. Acad. 9: 189, 1874.

MADIA ELEGANS Don subsp. **typica** nom. nov.—*M. elegans* Don in Lindl. Bot. Reg. 17: t. 1458, 1831.

MADIA ELEGANS subsp. **densifolia** (Greene) comb. nov.—*M. densifolia* Greene, Pittonia 3: 167, 1897. *Madaria densifolia* Greene, Fl. Franciscana 417, 1897. *Madia elegans* var. *densifolia* Jepson, Fl. W. Mid. Calif. 528, 1901.

Madia Wheeleri (Gray) comb. nov.—*Hemizonia Wheeleri* Gray, Bot. Calif. 1: 617, 1880. The type came from Monache Meadows, Tulare County, California. This species occurs in the

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[1] Bot. Gaz. 95: 177–208, 1933.

southern portion of the Sierra Nevada and in the San Antonio, San Bernardino and San Jacinto ranges of southern California. This plant is a close relative of *M. elegans* and its affinity here has not been recognized up to this time because its ray-akenes conform in width to the key-character type of Hemizonia. In other details, however, its ray-akenes are of the Madia type and other technical characters place it definitely in this genus.

MADIA EXIGUA (Smith) Gray, Proc. Am. Acad. 8: 391, 1872. The indexes and later authors have missed this publication of the combination, universally attributing it to Greene, Erythea 1: 90, 1893.

Madia nutans (Greene) comb. nov.—*Callichroa nutans* Greene, Pittonia 2: 227, 1892. *Blepharipappus nutans* Greene, l. c., 247. *Layia nutans* Jepson, Fl. W. Mid. Calif. ed. 2, 449, 1911. The closest relative of this plant is the following new species and both are local endemics in neighboring parts of the same general region. Together with *M. Rammii* Greene and *M. yosemitana* Parry, they form a common group of species.

Madia Hallii sp. nov. Annua, pumila, 5–18 cm. alta; caule superne divaricato 2–5-chotomo glanduloso-pubero; foliis subradicalibus numerosis anguste linearibus albo-hirsutis subintegerrimis, 5–20 vel 30 mm. longis, 0.7–1.7 mm. latis; pedunculis dense glandulosis nudis capillaribus elongatis 1–5 cm. longis monocephalis atropurpureis; involucro turbinato, 4.5–5.2 mm. alto, squamis linearibus crispe pilosis et cum paucis glandulis stipitatis breviter acuminatis; corollis luteis, radii 3–6, ligula flabelliformi 4.5–5.5 mm. longa, 6–8 mm. lata, disci 8–20 fertilibus 2.5–3 mm. longis, tubo pubenti, faucibus glabris, dentibus limbi hispidulis; antheris semi-exsertis, luteis; acheniis radii linearis paululum lateraliter compressis arcuatis nigris levibus, disci strictis 4–5-costatis, stipite dilatato; pappo (radii discique consimili) ca. 10-paleaceo brevissimo (0.2–0.3 mm. longe), paleis oblongis quadratisve erosa-fimbrillatis.

Inner Coast Range of eastern Lake and Napa counties, California, at elevations of 500 to 900 meters. *Type:* Near Knoxville, northeastern Napa County, May 27, 1931, *H. M. Hall 13094* (Dudley Herbarium of Stanford University; isotypes Berlin, CI, Gray, Kew, Mo, NY, UC, US). Other collections: Knoxville, *Baker 3079* (CA, Delessert, Gray, Kew, NY, Po, UC, US); west of Leesville, Lake County, *Heller 13123* (CA, CI, Del, DS); Lower Lake; Butts Canyon.

This very distinctive species is named in honor of the late Dr. H. M. Hall, who not only collected the type, but had long recognized this as an unnamed species and had studied it. Dr. Greene, in the course of routine determinations of the Baker sets, proposed a name by which this has been distributed to many herbaria as an unpublished species of Anisocarpus.

Adenothamnus

Adenothamnus, gen. nov.—Capitula heterogama, radiata, multiflora, floribus radii ligulatis femineis 1-seriatis fertilibus discique tubulosis hermaphroditis plus minusve fertilibus. Involucrum campanulatum, bracteis 1-seriatis subaequalibus herbaceis carinatis achaenia exteriora arte involventibus. Receptaculum convexum, in ambitu paleis chartaceis connatis circa flores hermaphrodites exteriores, in centro dense villosum. Corollae femineae tubo tenui, lamina patente, breviter 3–4-fida; hermaphroditae tubulosae, fauce paulla ampliata, limbo 5-dentato. Achaenia minute striata, radii oblonga, paulla incurva, a latere compressa, calva; disci nunc subcylindracea, nunc tenuia vacuaque, setis pluribus subaequalibusque 1-seriatis breviter plumosis.—Suffrutex erectus, corymboso-ramosus, totus glanduloso-pubescens. Folia alterna, integerrima, sessilia. Capitula majuscula, solitaria. Corollae flavae. Achaenia disci parce strigillosa, radii glabra. (*Aden,* gland + *thamnos,* shrub.)

Known only from the following species which is, accordingly, the type.

Adenothamnus validus (Brandegee) comb. nov.—*Madia valida* Brandegee, Zoe 4: 206, 1893. This anomalous plant is known only from the type collection made at San Antonio (now known as San Antonio del Mar), Lower California, by T. S. Brandegee, June 4, 1893. The type is at the University of California. This species differs from all those of the genus Madia in its shrubby habit, densely stipitate-glandular herbage quite lacking in other pubescence below the uppermost leaves and stems, large oblong heads, essentially glabrous corollas and in the numerous elongated plumose pappus-bristles. Although the technical characters of the heads for the most part find counterparts in one or another species of that genus, showing a degree of relationship between the two genera, the aspect of this plant is entirely foreign to Madia.

Hemizonia

Hemizonia, section Olocarpha DC. Prodr. 5: 692, 1836. As published, this section contained two species *H. luzulaefolia* DC. and *H. macradenia* DC. in that order. *Hemizonia luzulaefolia* is now universally regarded to be associated with *H. congesta* DC. in the section *Euhemizonia.* Holocarpha as a genus, with its single species *H. macradenia,* was described by Greene, Fl. Franciscana 426, 1897, thereby setting the type of DeCandolle's section. We have concluded that four other species are phylogenetically associated with *Hemizonia macradenia* DC. and should be included in this section, namely, *H. virgata* Gray, *H. Heermannii* Greene and the two following new species:

Hemizonia obconica Clausen et Keck, sp. nov. Annua erecta 2–8 dm. vel ultra altitudine; caule rigido infra mediam partem saepius simplici supra divaricato-ramoso a basi patenter hispido superne viscido glutinosoque; foliis linearibus vel lineari-oblanceolatis, inferioribus inciso-dentatis hispidulis basi longe attenuatis, superioribus integerrimis, summis minimis apice glanduloso-truncatis; pedicellis moderate longis divaricatis; capitulis paniculatis; involucro obconico, 4–5 mm. alto, squamis cum paucis glandulis rigido-stipitatis ornatis ceteroqui glabris vel subglabris; antheris luteis.

Scattering colonies in the Coast Ranges from Contra Costa County to western Fresno County and in the Sierra Nevada foothills of Fresno and Tulare counties, all in California. *Type:* Part way up grade one half mile north of Tesla, Alameda County, at *ca.* 300 m. elevation, *Keck & Stockwell 2501* (Dudley Herbarium; isotypes to be distributed).

The specific name denotes the common shape of the involucre, a character distinguishing this species from *H. virgata* and *H. Heermannii.* It is readily distinguished from *H. Heermannii* by the lack of dense puberulence above, the few (20 or less) gland-tipped processes of the involucral bracts and the broad receptacle; from *H. virgata* it differs in anther-color, paniculate arrangement of the heads and hispid lower herbage. *Hemizonia obconica* has been confused hitherto with *H. virgata* and its distinctive characteristics were not observed clearly until cytological studies had shown that two species were involved in the *H. virgata* complex. *Hemizonia obconica* is a species with a haploid chromosome-number of 6[2] (like *H. Heermannii*), while in *H. virgata* the number is 4. The species do not form fertile hybrids whether growing side by side in nature or as the result of artificial garden crossings.

Hemizonia vernalis sp. nov. Annua erecta gracilis simplex 15–22 cm. alta omnino hirsuta superne paululum viscida; foliis alternis (infimis paucis oppositis), inferis lineari-oblanceolatis acutis argute incurvo-serratis, superis sessilibus integris scabriusculis, superissimis aliquanto bracteatis laxis; capitulis paniculatis ad apicem caulis aggregatis; involucro 5–6 mm. alto, squamis hirsutis cum ca. 5–10 rigide adscendentibus stipitibus apice glandulam truncatam gerentibus; paleis receptaculi discum totum occupantes intimis hyalinis linearibus apice pubente; corollis luteis, radii 8–10, disci 20–35; antheris nigris; acheniis radii fertilibus anguste obovatis ca. 4 mm. longis olivaceo-nigris apice intus breviter rostratis, disci sterilibus.

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2 Chromosome numbers in this paper have been supplied by Dr. J. Clausen.

Known only from the type collection taken at Base Camp (of the San Joaquin Light and Power Company), junction of the North and South Forks of Kings River, Fresno County, California, March 10, 1923, *W. B. Duncan* (Dudley Herb., No. 125323). This station is between 300 and 700 m. elevation.

This slender vernal herb, hirsute throughout and very lightly glandular, is decidedly distinct from the other species of this section, which are autumnal, glutinous and viscid.

Hemizonia fasciculata (DC.) Torr. et Gray subsp. **typica** nom. nov.—*Hartmannia fasciculata* DC. Prodr. 5: 693, 1836. *Hemizonia fasciculata* Torr. et Gray, Fl. N. Am. 2: 397, 1843.

Hemizonia fasciculata subsp. **ramosissima** (Benth.) comb. nov.—*H. ramosissima* Benth. Bot. Voy. Sulph. 30, 1844. *H. fasciculata* var. *ramosissima* Gray, Syn. Fl. 1^2: 310, 1844.

Hemizonia Lobbii Greene subsp. **typica** nom. nov.—*H. Lobbii* Greene, Bull. Torr. Club 9: 109, 1882. *H. fasciculata* var. *Lobbii* Gray, Syn. Fl. 1^2: 310, 1844. *Deinandra Lobbii* Greene, Fl. Franciscana 425, 1897.

Hemizonia Lobbii subsp. **pentactis** subsp. nov. Caule patenter hirsuto; foliis viridibus albo-pilosis; involucri squamis hispidulis parce glandulosis; ligulis 5; fl. disci 6.

Salinas Valley, California, from the region to the east of King City south-eastward to the headwaters of the Estrella River. *Type:* East side of the Salinas River, opposite San Miguel, San Luis Obispo County, April 27, 1934, *Keck & Clausen 2836* (Dudley Herb.; isotypes CI, UC, Kew, G).

This subspecies differs from subsp. *typica* in the flower-number but is not otherwise separable. Both subspecies have individual geographic ranges, but meet at a number of points and there intermediate types occur abundantly. The more glandular, 5-rayed form from the vicinity of Stanford University, Santa Clara County, may be tentatively referred to subsp. *pentactis*. *Hemizonia Lobbii* differs from *H. fasciculata,* with which it has frequently been confused, by the pinnatisect basal leaves with linear lobes, the low, intricately branched habit, the grayish cast to the herbage caused by the abundant white hairs, the pustulate hairs of the involucral bracts and the separate geographic range to the northward of *H. fasciculata.* The two species differ in chromosome-number (*H. fasciculata* n = 12; *H. Lobbii* n = 11) and we have failed in our attempts to form hybrids between them.

Hemizonia pallida sp. nov. Annua omnino villosa-hirsuta; caule erecto 2–8 dm. alto stricto albo e basi vel superne adscendenter ramoso in inflorescentiam glandulis stipitatis parce adsparsis; foliis alternis, inferioribus linearibus vel oblanceolatis argute dentatis 5–10 cm. longis 3–6 vel 10 mm. latis, superioribus integerrimis gradatim reductis; corymbis ramos terminantibus planiusculis vel rotundatis; capitulis multis brevi-

pedunculatis; involucro late campanulato vel hemisphaerico 4.5–6.5 mm. alto, 5–8 mm. lato, squamis lanceolatis acutis acuminatisve hispido-hirsutis et glandulari-puberulis, marginibus ciliolatis; paleis receptaculi inter radium et discum gerentibus breviter hirsutis et superne brevissime glandulari-puberulis connatis; corollis flavis, radii 8–12, ligulis conspicuis cuneatis 6–10 mm. longis, tubo glandulari-pubescenti, disci 10–25, 3.4–4.4 mm. longis extus cum glandulis subsessilibus ornatis supra mediam partem abrupte ampliatis; antheris flavis; acheniis radii 2.2–2.8 mm. longis obovatis transverse rugosis nigris, areola robuste rostrata, stipite (ad ventralem situm portatur) calloso; acheniis disci sterilibus glabris vel minutissime paululumque glandularis; pappo 4–8 paleaceo, paleis inaequalibus laciniatis vel parce fimbriatis ca. 0.8 mm. longis.

Known only from Tulare and Kern counties, California, on the plains at the head of the San Joaquin Valley, and in Red Rock Canyon on the western boundary of the Mohave Desert, at altitudes of 100 to possibly 1000 m. *Type:* Head of the San Joaquin Valley, 5.3 miles north of Grapevine, Kern County, in gravelly soil on open plain, May 6, 1933, *Keck & Heusi 2255* (Dudley Herb.; isotypes Berlin, CA, Copenh, FM, G, Kew, Mo, Phila, Po, NY, UC, US). This locality is 25 miles (40 kilometers) due south of Bakersfield.

A common plant in its range, this spring-flowering species has been generally keyed out to the early form of *H. angustifolia* DC., a black-anthered species of the coast, but its true affinities are with *H. Kelloggii* Greene and the following new species, *H. mohavensis.* The three in common have yellow-anthers, and *H. pallida* and *H. Kelloggii* differ from the other species of their section of Hemizonia in the light yellow color of their flowers and in having the chromosome number n = 9. *Hemizonia pallida* has many more flowers in both ray and disk than *H. Kelloggii* and *H. mohavensis,* each of which have five rays and six disks.

Hemizonia mohavensis sp. nov. Annua erecta herbacea undique mollissima viscida-pubescens; caule 15–30 cm. alto virgato subsimplici vel (praecique superne) divaricato-ramoso; foliis alternis, inferioribus oblanceolatis subintegerrimis basi in petiolum brevem attenuatis, superioribus integerrimis oblongo-lanceolatis obtusis basi amplexicaulibus, foliis rameis multo minoribus usque ad capitula gerentibus; inflorescentia corymboso-expansa planiuscula vel rotundata; capitulis ad apices ramorum dense glomerulis plerisque sessilibus; involucro ovato 4.8–6 mm. alto, squamis lanceolatis utroque acutiusculis dorso subcarinatis dense hirtellis et prominenter glandulari-puberulis; paleis receptaculi inter radium et discum gerentibus ad mediam connatis; corollis luteis, radii 5, ligulis conspicuis late obovato-rotundatis 5–6 mm. longis, disci 6 ca. 3.5 mm. longis extus cum

glandulis stipitatis ornatis, faucibus turbinatis tubo proprio longitudine subaequante; antheris luteis; acheniis radii plus minusve 2 mm. longis anguste obovatis 3-angulosis laevibus rugulosisve, areola gracile rostrata, stipite inverso albo-calloso; acheniis disci sterilibus supra mediam partem cum brevissime glandulari-puberulis paulo ornatis; pappo ca. 6–8 paleaceo, paleis inaequalibus in latum plerisque quadratis eroso-laciniatis brevissimis plus minusve connatis ca. 0.5 mm. longis.

Type: Mohave River, at confluence with Deep Creek, Mohave Desert, San Bernardino County, California, at 900 meters elevation, Sept. 17, 1933, *Keck 2531* (Dudley Herb.; isotype CI). Growing on low sand-bars in the river bed with Verbascum thapsus, Mimetanthe pilosa, Hemizonia Fitchii, Boisduvalia sp., etc. Only some ten plants were found. This location was visited with Mr. Louis C. Wheeler, of La Verne, who had discovered this colony earlier in the year. His number 1961 in the Carnegie Institution collections, made July 18, 1933, shows characteristics of the foliage better than the type which, however, excels in fruit characters. The only other specimen to be referred to this species was collected on the Banning-Idyllwild Road, on the northwestern side of Mount San Jacinto, Riverside County, *Munz & Johnston 8880* (Pomona College). The label reads, "single plant in clearing in chaparral," and the slender stem is unbranched with spicate arrangement of the heads below the terminal glomerule of 4 or 5 members.

Southern California has been intensively explored botanically, at least in these regions, so we must infer that this species is exceedingly rare and in a precarious position as regards extinction. Fortunately we have been able to grow a few plants in the garden and so study the species further. Its haploid chromosome number in common with *H. Lobbii* is eleven. But it will surely never be confused with that species. Its flower-number is the same as *H. fasciculata* and *H. Kelloggii* and from consideration of its characters as a whole it may be said to stand between those species. The soft glandular pubescence separates it from *H. fasciculata* while the congested heads of *H. mohavensis* are never approached in *H. Kelloggii*. In addition, *H. mohavensis* differs from every other tarweed in the details of its minute pappus-paleae.

Hemizonia paniculata Gray subsp. **typica** Hall nom. nov.— *H. paniculata* Gray, Proc. Am. Acad. 19: 17, 1883. In his original description Gray indicated the number of disk-flowers as 10 to 12. No type specimen was pointed out, but the collectors were named in the following order: *Brewer, Parish, Jared.* As the number of disk-flowers per head on the Brewer specimen is at least 15, which is considerably above the 10 to 12 given by Gray, this indicates the original description was not based upon the first specimen cited, at least as to this important feature,

and also because of the fragmentary nature of this specimen it is excluded from consideration as the type. The Parish collection referred to is *Parish 1419,* from near Temecula, and was the only plant from this collector in the Gray Herbarium at that time, and since this agrees very well with the original description it is now selected as the type. This leads to southern California as the type locality and to the southern form as subsp. *typica.* It occurs from Riverside County to northern Lower California.

Hemizonia paniculata subsp. **increscens** Hall subsp. nov. Tota breviter pubescens praesertim superne stipitata-glandulosa; corollis radii luteis 8–13, disci 14–30.

Common in open fields in northern Santa Barbara County and southern San Luis Obispo County; infrequent northward to the lower Salinas Valley, Monterey County, all in California. *Type:* 7.5 miles (12 km.) southwest of Arroyo Grande, San Luis Obispo County, June 7, 1931, *H. M. Hall 13136* (Dudley Herb.; isotype CI).

Hemizonia paniculata may be divided rather satisfactorily into a northern and a southern subspecies, these differing from each other in the number of disk-flowers. In the north this number is 14 to 30, in the south it is only 8 to 13. Between the two there is a geographic gap of about 270 km. (170 mi.) over which the species is entirely lacking. Although no appreciable difference other than number of disk-flowers has been found (aside from a resulting modification in size and shape of head) it is believed that there is here a definite and real systematic as well as geographic separation. There is a slight amount of overlapping in number of flowers among inland plants of subsp. *increscens* in which it may fall as low as 10 in smallest specimens, but the number rarely falls below 14 and the average for the subspecies is close to 20. This information is based on a large number of counts and is found to be statistically very significant.

Subspecies *increscens* is composed of two distinguishable races, one that occurs in the valleys opening directly to the sea in which the ray-flowers are usually 13 but varying to 10, the other appears further inland and the number of rays is consistently 8 (like subsp. *typica*). Where these races meet all intermediate numbers are found. The type is characteristic of the former of the two.

These notes on *H. paniculata* have been taken largely from manuscript of Dr. Hall, who made intensive field studies of the species and took exhaustive flower-counts. He proposed the name *increscens,* had discussed the subspecies in a public lecture[3] and was preparing to publish it.

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[3] Hall, H. M. "Heredity and Environment—as Illustrated by Transplant Studies," Sci. Month. 35: 301, 1932.

Hemizonia martirensis sp. nov. Tota glabrata; caule erecto a basi parce hispido ceteroqui glabro rubello-brunneo ca. 3–5 dm. alto; foliis alternis, inferioribus junioribus ignotis, superioribus subintegerrimis saepe bidentatis semiamplexicaulibus obscure scabro-hispidulis, foliis ramulis multo minoribus (3–7 mm. longis) subimbricatis linearis adpressis integerrimis glaberrimis aliquando glandulari-subpunctatis; inflorescentia dure paniculata sed laxiuscula; pedicellis viscidis; involucro hemisphaerico ca. 5 mm. alto, squamis lanceolatis rotunde complicati dorso dense glanduliferis non pubescentibus, margine breve ciliata; paleis receptaculi inter radium et discum gerentibus ad mediam connatis; corollis flavis, radii 8, ligulis conspicuis obovatis 6–7.5 mm. longis, disci 11–21, 5 mm. longis extus cum minutissimis glandulis stipitatis ornatis; antheris flavis; acheniis radii 2.5–3 mm. longis obovatis leviter transverse rugosis nigris, areola breviter et robuste rostrata, stipite calloso; acheniis disci omnino sterilibus paululum viscido-puberulis; pappo plerisque 7–10 paleaceo, paleis anguste oblongo-attenuatis paulo laciniato-fimbrillatis.

Type: granitic soil of foothill region at base of San Pedro Martir Mountains, in immediate vicinity of San Jose, 25 miles east of San Telmo, Baja California, Mexico, Feb. 23, 1931, *Ada Meling 2* (Dudley Herb.; isotype CI). Not otherwise known. Miss Meling collected several numbers on her father's ranch at the behest of Dr. I. L. Wiggins of Stanford University, and it is to him that I am grateful for the opportunity of putting this interesting species on record. It is doubtless most closely related to *H. paniculata,* but the color of the flowers and anthers and the sterile disk-akenes indicate common characters with *H. pallida* and *H. Kelloggii.* The almost complete absence of pubescence parallels the case of *H. fasciculata.*

Hemizonia angustifolia DC. subsp. **typica** nom. nov.— *H. angustifolia* DC. Prodr. 5: 692, 1836. *H. corymbosa* (DC.) Torr. et Gray is found to belong to subsp. *typica,* being the spring-flowering form with deeply pinnatifid leaves occurring well above the middle, while the type of *angustifolia* represents the fall-flowering form with pinnatifid leaves confined to the lower portion of the plant.

Hemizonia angustifolia subsp. **macrocephala** (Nutt.) comb. nov.—*H. macrocephala* Nutt. Jour. Acad. Phila. II, 1: 175, 1848. In this subspecies the heads are congested in terminal rounded leafy-bracted clusters 2 to 4.5 cm. thick, heightening the effect of their large size. Occurrence of the subspecies is in southern Monterey and northern San Luis Obispo counties, California.

Hemizonia Halliana sp. nov. Annua, erecta, herbacea, praecipue glabra 2–5 dm. alta; caule fistuloso virgato candidulo-rubicundulo glaberrimo ad inflorescentiam foliaceo simplici usque a basi praeter medianum super dense corymboso; foliis usque

ad basim alternis lineari-lanceolatis sessilibus acutis vel obtusis utrimque glaberrimis in margine aliquanto scabro-ciliatis plerisque integris infimorum aliquantis patenter brevi-dentatis 5–8 cm. longis 3–9 mm. latis; corymbis ramos terminantibus planiusculis vel rotundatis; pedicellis (et bracteis) dense viscido-pubescentibus; involucro late hemisphaerico 5–7 mm. alto, squamis lanceolatis breve acuminatis dense glandulari-puberulis ad apicem superne aliquanto ciliolatis; paleis receptaculi inter radium et discum gerentibus plerisque 14–15 tres partes longinquitatum connatis; corollis luteis, radii 10–14, ligulis conspicuis quadrato-oblongis ca. 5.5 mm. longis, tubo viscido, disci 30–60, 3.5–4 mm. longis, faucibus ampliatis, tubo visciduIo; antheris luteis; acheniis radii 3.5–4 mm. longis obovato-prismaticis 4-nervalibus laevigatis nigris, nervo intus stricto (non incurvo), areola breviter rostrata, stipite magno-calloso; acheniis disci omnino sterilibus glaberrimis compressis calvis rarissimo cum rudimentari paleaceo pappo.

Type: 1.5 miles east of Cholame, northeastern San Luis Obispo County, California, on the dry flood plain of Cholame Creek, elevation 365 m. (1200 ft.), May 4, 1933, *Keck & Heusi 2170* (Dudley Herb.). A large set of isotypes awaits distribution. The habitat of the type was the bed of an alkaline "dry lake" which was colored for a length of at least 3 miles (nearly 5 km.) by this species, the dominant plant of the area. The heavy adobe soil was deeply cracked into a mosaic pattern of blocks giving the impression that the seedlings had germinated in standing water. It was collected here previously by Munz, no. 10157 (Po, UC), and determined as *Madia radiata* to which it bears a remarkable resemblance.

The description given above was based on the type collection. It may be amplified by consideration of plants from the only other known station for the species, on Lewis Creek, northeast of Lonoak (2 miles from intersection of Bitterwater road), Monterey County, Apr. 25, 1934, *Keck & Clausen 2774* (CI, DS). Only four individuals could be found here. These differ from the type only in being more pubescent in the upper half. Below they are essentially glabrous, but toward the heads these plants are more densely villous. Both collections are viscid within the inflorescence with small but very numerous glands that impart to the species a strong, balsamic odor, not unlike that of *H. floribunda* or *H. angustifolia.*

Hemizonia Halliana is the most unique of the ten species in its section. In common with *H. angustifolia* it has 10 gametic chromosomes and before this fact was known some of the characters of the heads had led to the supposition that a degree of relationship existed between the two species. But the shape of the ray-akene, the fistulous and gleaming stems, the entire and ciliolate leaves, the absence of pappus, not to mention the choice of

habitat, are characters new to the section. It is a pleasure indeed to associate the name of the late Dr. H. M. Hall, foremost student of the Madinae, with this outstanding plant.

Hemizonia, section **Centromadia** (Greene) comb. nov.—*Centromadia* as a genus, Greene, Man. Bot. S. F. Bay 196, 1894. A synopsis of this section follows:

Hemizonia pungens (Hook. et Arn.) Torr. et Gray subsp. **typica** nom. nov.—*Hartmannia ? pungens* Hook. et Arn. Bot. Beech. 357, 1838. *Hemizonia pungens* Torr. et Gray, Fl. N. Am. 2: 399, 1843. We wish to point out a coastal subspecies with smooth peduncular bracts and an interior subspecies with scabrous-puberulent bracts. Therefore it is important to fix the type of the species as regards this character. We have a photograph and a small fragment of the type which is in Hooker's Herbarium at Kew, collected in "California" by David Douglas. The type falls between the coastal and inland forms as regards scabridity, and doubtless came from the area in which the two meet. As Douglas did not collect to the east of the Inner Coast Range, as far as we know, it is possible that the type came from the northern side of San Francisco Bay where similar forms may be found. We interpret the type, then, as representing the coastal material which is, for the most part, very much smoother than the type specimen. This material therefore falls within subsp. *typica,* and may be found from Monterey County to Colusa County, reappearing in Siskiyou County, California, and adjacent Oregon. *Centromadia maritima* Greene is a synonym.

Hemizonia pungens subsp. **interior** subsp. nov. Foliis bracteisque scaberrimo-puberulis; capituliis subsolitariis; receptaculi squamis pungentibus.

Western borders of the Mohave Desert northward through the San Joaquin Valley, where it is very abundant, to San Joaquin County, California. *Type:* Nilegarden Station, 3 miles west of Manteca, San Joaquin County, June 26, 1932, *Keck 1503* (Dudley Herb.; isotypes CA, CI, Copenh, Po, UMontana).

Hemizonia pungens subsp. **laevis** subsp. nov. Foliis bracteisque parce setoso-ciliatis ceteroqui glaberrimis; capitulis parvis; receptaculi squamis obtusis vel acutiusculis non cuspidatis.

Southern California, from the vicinity of Los Angeles to San Bernardino and San Diego counties. *Type:* San Bernardino Valley, at an altitude of 300 m., July 8, 1916, *S. B. Parish 10972,* in University of California distribution no. 278 (Dudley Herbarium).

Hemizonia Parryi Greene subsp. **typica** nom. nov.—*H. Parryi* Greene, Bull. Torr. Club 9: 16, 1882. The type is from Calistoga Springs, Napa County, California. The upper leaves and bracts in particular are dotted with subsessile, granular glands, not scabrous, the subtending bracts often exceed the involucre in

length and the anthers are yellow. Presence of pappus and nonpungent chaff are specific characters. Typical *H. Parryi* occurs for the most part to the north of San Francisco Bay and is rather infrequent.

Hemizonia Parryi subsp. **rudis** (Greene) comb. nov.—*Centromadia rudis* Greene, Man. Bot. S. F. Bay 197, 1894. This subspecies differs from subsp. *typica* in the scabrid-puberulence of its leaves and bracts, and the absence of glands; the ligules frequently fade brick-red. Subsp. *rudis* has small heads and yellow anthers. It is a parallel ecotype to *H. pungens* subsp. *interior,* the scabrous puberulence of each being directly associated with their dry and hot inland habitats. Subsp. *rudis* occurs northeastward from San Francisco Bay well up into Sacramento Valley. The type came from Vacaville, Solano County.

Hemizonia Parryi subsp. **Congdoni** (Rob. et Greenm.) comb. nov.—*H. Congdoni* Rob. et Greenm. Bot. Gaz. 22: 169, 1896. *Centromadia Congdoni* C. P. Smith, Muhlenb. 4: 73, 1908. *C. pungens* var. *Congdoni* Jeps. Man. Fl. Pl. Calif. 1087, 1925. Here are included the non-glandular, non-scabrous forms of *H. Parryi* which form a natural geographic subspecies in the region from Contra Costa County to Salinas Valley, California. The anthers are yellow.

Hemizonia Parryi subsp. **australis** subsp. nov. Tota dense glandulari-puberula villosaque; capitulis parvis; ligulis flavis interdum in senectutibus rubescentibus; antheris nigris.

This occurs for the most part in the proximity of the coast from Los Angeles to northern Lower California; rare in Santa Barbara County. *Type:* Seal Beach, Orange County, California, Sept. 29, 1933, *Keck 2537* (Dudley Herb.). A large set of isotypes awaits distribution.

A hiatus of 270 km. separates subsp. *australis* from subsp. *Congdoni,* and there is a gap of 425 km. between subsp. *australis* and subsp. *typica* with which it bears a greater resemblance. Subsp. *australis* is more densely pubescent than subsp. *typica* and in addition its heads are surrounded by short bracts that fail to exceed them in length. This and subsp. *rudis* are the taller of the subspecies.

Hemizonia perennis (Greene) comb. nov.—*Centromadia perennis* Greene, Pittonia 3: 26, 1896. This species of Lower California, with strictly perennial base and sheathing lower leaves, is apparently most nearly allied to its geographic neighbor, *H. Parryi* subsp. *australis.* The type came from Cañon Salado, near San Antonio Del Mar, and was collected by T. S. Brandegee. We have seen a second collection, from Playa, San Vicente (35 km. south of Santo Tomas), *Cooper 77* (Dudley Herb.).

Hemizonia Fitchii Gray completes the list of members of this section.

Lagophylla

Lagophylla dichotoma Benth. subsp. **typica** nom. nov.—*L. dichotoma* Benth. Pl. Hartw. 317, 1849. The type came from Sacramento Valley, but we have seen specimens from as far north as Merced County only, thence southward to Tulare County and westward to the Inner Coast Range of Monterey, Fresno and San Benito counties. This is one of the very rare tarweeds.

Lagophylla dichotoma subsp. **minor** subsp. nov. Planta 1–3 dm. alta; involucri squamis lanceolatis eglandulosis infero dimidio dense albo-villoso, villis longis incurvis septatis praecipue prope marginem, apice acuminato parce villoso etiam puberulis; acheniis radii late oblanceolatis nigris laevigatis glaberrimis 0.8–1.3 mm. latis nervo ventrali evidenti.

Foothills of the Coast Range and Sierra Nevada surrounding the Sacramento Valley, extending westward into Lake and Napa counties, California. *Type:* bridge over Pope Creek, just south of Walters Spring, Napa County, May 29, 1933, *Keck 2338* (Dudley Herb.). A large set of isotypes awaits distribution.

Lagophylla ramosissima Nutt. subsp. **typica** nom. nov.—*L. ramosissima* Nutt. Trans. Am. Phil. Soc. II, 7: 391, 1841.

Lagophylla ramosissima subsp. **congesta** (Greene) comb. nov.—*L. congesta* Greene, Bull. Torr. Club 10: 87, 1883. *L. ramosissima* var. *congesta* Jeps. Fl. W. Mid. Calif. 539, 1901.

Layia

Layia Munzii sp. nov. Caule a basi ramoso erecto 2–3.5 dm. alto deorsum glabrato vel parce hispidulo superne viscido-puberulo cum paucis nigris stipitatis glandulis praecipue in receptaculo ornato immaculato; foliis utrimque glabratis scabrociliatis praecipue superioribus parce villosis et viscidis, radicalibus lineari-oblongis 2–4 cm. longis, 4–8 mm. latis, pinnatifidis, lobis brevi-oblongis integris, caulinis consimilibus supremis integerrimis; capitulis pedunculos apice nudiusculos terminantiis; involucro depresso-hemisphaerico 7–8.5 mm. alto, squamis lineari-oblongis crassiusculis glabratis vel parce hispidis ad apicem paullo glandulari-puberulis obtusis vel rotundis; paleis receptaculi plerisque 20–21, 6–6.5 mm. longis inter radium et discum gerentibus acutis liberis; corollis radii 10–15, ligulis conspicuis luteis apicibus albis obovatis 9–12 mm. longis, 6–9 mm. latis, lobis oblongis, tubo pubescenti 1–1.5 mm. longo; corollis disci ca. 75, 3.6–5 mm. longis, tubo puberulo, lobis hispidulis; antheris nigris; acheniis radii 2.8–3.5 mm. longis oblanceolatis compressissimis glabris glabratisve, disci 2.5–4 mm. longis dense strigosis circum areolam numerosis capillaceis villis gerentibus; pappo 2.3–3.4 mm. longo ochroleuco, paleis 9–11 lineari-lanceolatis attenuatis subintegerrimis.

Eastern San Luis Obispo County, California, from Cholame to Carriso Plains. *Type:* 32 miles (51 km.) east of Paso Robles, April 8, 1926, *P. A. Munz 10149* (Pomona College Herb.). Also taken at Cholame, *Wiggins 5784* (DS), and Carisso Plains, Mar. 31, 1910, *Condit* (DS, UC).

The type was collected on a botanical expedition in which several students, among them the writer, accompanied Dr. Munz, so there is a particular pleasure connected with naming this handsome plant *Layia Munzii.*

The closest relative of this species is probably *L. Fremontii* from which it is amply distinct by the absence of inner chaff on the receptacle, the presence of black glands on the herbage, in most cases by the shape of the pappus paleae, and by its different geographic distribution. It is about as close morphologically to *L. Jonesii,* in parallel fashion a restricted endemic of coastal San Luis Obispo County.

Layia leucopappa sp. nov. Erecta 15 cm. alta; caule paucirameo a basi parce hispidulo superne aliquanto viscidulo-puberulo cum paucis nigris stipitatis glandulis ornato; foliis ciliatis cum paucissimis prominentibus glandulis ornatis, supra parce villosis subtus glabris, inferioribus lineari-oblanceolatis plerisque 2 cm. longis, 4 mm. latis, pinnatifidis sessilibus, superioribus plerisque 1 cm. longis integerrimis; capitulis pedunculos apice nudulos terminantiis; involucro late hemisphaerico 6.3–7 mm. alto, squamis lineari-oblongis papillari-hirsutis et parce nigro-glandulosis, apice obtuso dilatatiusculo; paleis receptaculi ca. 20, 5.4–5.7 mm. longis inter radium et discum gerentibus acutis acuminatisve liberis; corollis radii 8–12, ligulis conspicuis ut videtur albis obovatis plerisque 8–9 mm. longis, disci ca. 60, 3.7–4.9 mm. longis undique pubescentibus; antheris flavis; acheniis radii 2.5–2.7 mm. longis oblanceolatis paullo arcuatis definite albo-sericeis, disci 2.5–2.9 mm. longis dense albo-sericeis circum areolam numerosis capillaceis villis gerentibus anguste turbinatis; pappo 1.7–2.2 mm. longo niveo, paleis 10 lanceolatis acutis acuminatisve subintegerrimis.

Known only from the type individual, collected near Comanche Point, San Joaquin Valley, California, April 3, 1927, by *E. Roy Weston 583* (Calif. Acad. Sci. Herb.). This locality is in Kern County, nearly 10 km. south of Arvin, and on the U. S. Geological Survey map is known as Tejon Hills.

The affinities of this species are with *L. Munzii, L. Jonesii* and *L. Fremontii.* It differs from the first of these in having white flowers, yellow anthers, plump, sericeous ray-akenes, and shorter, snow white, less elongated pappus of the texture of tissue paper. There is a resemblance between this species and *L. Jonesii* in pappus and ray-akenes; otherwise it is probably less similar to that species than is *L. Munzii.* In addition to those characters that separate *L. leucopappa* from *L. Munzii,* it is sepa-

rated from *L. Fremontii* by the absence of inner chaff, and the presence of black stipitate glands.

LAYIA GLANDULOSA (Hook.) Hook. et Arn. subsp. **typica** nom. nov.—*Blepharipappus glandulosus* Hook. Fl. Bor. Am. 1: 316, 1833. *Layia glandulosus* Hook. et Arn. Bot. Beech. 358, 1838. This is the most polymorphic species of the genus, with an extensive range from British Columbia southward to Lower California and Arizona. Although variation extends to all parts of the plant, recombinations of the various characters are so frequent as to permit the proposal of but one segregate subspecies at present.

LAYIA GLANDULOSA subsp. **lutea** subsp. nov. Corollae radii et disci luteae.

Restricted to San Benito County, California, where it is frequent. *Type:* Bear Valley, north of Pinnacles post office, May 1, 1933, *Keck 2017* (Dudley Herb.). Isotypes to be distributed.

This subspecies, with golden-yellow flowers, breaks down the universally applied key character of flower-color for *L. glandulosa,* but this had already become inevitable by the discovery of white forms assignable to the yellow *L. pentachaeta. Layia glandulosa* is distinguished by the ten broad pappus bristles, hispid pubescence, for the most part entire leaves and incidentally, by its almost universal occurrence on sandy soil.

Carnegie Institution of Washington.
Stanford University, October 30, 1934.

CRITICAL NOTES ON ERIOPHYLLUM LAG.—III

LINCOLN CONSTANCE

The misinterpretation of Bahia leucophylla DC.

Perhaps no specific name applicable to a member of the genus Eriophyllum has been more diversely and erroneously interpreted than that of Bahia leucophylla of de Candolle. The original material was collected (cf. Prodr. 5: 657. 1836) by "Nee et Haenke," at "Nootka et Mullgrave" (Malaspina Expedition, 1791).

The specific name (as "leucophyllum") has been subsequently recombined as follows: Eriophyllum caespitosum var. leucophyllum Gray (Proc. Am. Acad. 19: 26. 1883), Eriophyllum leucophyllum Rydb. (Mem. N. Y. Bot. Gard. 1: 422. 1900), Eriophyllum leucophyllum Howell (Fl. N. W. Am. 1: 355. 1903), and Eriophyllum lanatum var. leucophyllum Carter et al. (Prel. Cat. Fl. Vancouver and Queen Charlotte isls., Prov. Mus., Victoria, B. C., 82. 1921).

Although still including (in most cases) the original collection, the name was so twisted or amplified as to embrace also one or more of the following phases of Eriophyllum lanatum var. integrifolium (Hook.) Smiley:

1. Rocky Mountain phase (Trichophyllum integrifolium Hook. Trichophyllum multiflorum Nutt. etc.): Walp. Rept. Bot. Syst. 6: 175. 1846–7; Torr. et Gray, Fl. N. Am. 2: 375. 1841–3; Hook. Lond. Jour. Bot. 6: 248. 1847; Porter, U. S. G. S. Terrs., Prel. Rept. pt. 4, 486. 1871; Coulter, U. S. G. S. Terrs. 6^3: 770. 1873; Parry, Am. Nat. 8: 13. 1874; Rydb. l. c.

2. Walla Walla Plateau phase (This has not, I believe, been specifically segregated): Gray, Proc. Am. Acad. 19: 26. 1883; Howell, l. c.; Rydb. l. c.

3. Great Basin and Harney Plateau phase (Eriophyllum Watsoni Gray, Eriophyllum trichocarpum Rydb.): Eaton, in Wats. U. S. G. Expl. 40 Par. 17. 1871; Anderson, Nev. Min. Bien. Rept. 1869–70, 122. 1871; Rothrock, U. S. G. S. w. 100 Par. 6: 167. 1878.

4. High Sierra Nevada phase (Eriophyllum lutescens and monoense Rydb. Eriophyllum nevadense Gdgr. etc.): Bolander, Enum. Pl. 1866, 11. 1867.

The writer endeavored to obtain material from the two type localities: Nootka (western Vancouver Island) and Mullgrave (Yakutat Bay, Alaska). No authentic record of the occurrence or collection of Eriophyllum in Alaska was obtainable. An examination of representatives of the genus (from the Provincial Museum, Victoria, B. C., and the National Museum of Canada, Ottawa) collected on Vancouver Island, revealed none which could not be referred to typical Eriophyllum lanatum (Pursh) Forbes (Eriophyllum caespitosum Dougl.).

I have recently received from the Conservatoire Botanique de la Ville de Geneve a photograph of at least part of the original collection, bearing the data mentioned above. Although the original material is of specimens somewhat smaller than ordinary, with fewer-flowered heads, the leaves slightly more tomentose, and their pinnation partially suppressed, the writer experiences no doubt in assigning the material to typical Eriophyllum lanatum. The specimens, it is thought, are dwarfed individuals from an ecologically unfavorable habitat, exhibiting appropriate modifications. The leaves, involucres, and geographical occurrence all demonstrate the correctness of this determination.

The pappus, which was described as consisting of four lanceolate acute paleae alternating with four shorter obtuse ones, was believed to be distinctive, but, in view of the variability of this structure throughout the species and even the genus, this distinction can scarcely be maintained. This removes the last character of supposedly specific or varietal value.

Bahia leucophylla DC., then, becomes a synonym of Eriophyllum lanatum (Pursh) Forbes, a disposal which should conclude almost a century of successive misinterpretations.

University of California, Berkeley,
January, 1934.

NOTES ON MONARDA: THE SUBGENUS CHEILYCTIS.

CARL EPLING

The present paper records the results of a study begun in 1923 at the Missouri Botanical Garden and continued from time to time both in this country and abroad since that year. A subsequent paper will deal with the Section *Eumonarda.* The study is based especially upon the material in the herbaria of the United States National Herbarium, the Philadelphia Academy of Natural Sciences, the New York Botanical Garden, the Gray Herbarium, the Missouri Botanical Garden, the Field Museum, and the University of Texas. In addition, types and other historical material were consulted at the Linnean Herbarium, the British Museum, the Jardin des Plantes at Paris, the Berlin Botanic Garden, the Royal Botanic Gardens at Kew, and the Delessert and Boissier Herbaria in Geneva. To the directors of these institutions and to their associates the author makes grateful acknowledgment.

MONARDA Sect. CHEILYCTIS Raf. Med. Fl. 2: 64, 1830.

Cheilyctis Raf. Journ. Phys. 89: 99, 1819.

Monarda sect. *Coryanthus* Nutt. Trans. Am. Phila. Soc. 5: 186, 1834.

Perennial or annual herbs of erect habit and intermediate size, usually puberulent, less often pubescent, frequently virgate, more often branching in the upper axils, less often at the base; leaves prevailingly oblong or elliptical, rarely linear, for the most part 3–5 cm. long, on petioles usually less than the width of the blade; flowers crowded into axillary glomerules which are subtended by an involucre of bracts; bracts mostly entire, either ovate, tending to rotund, or elliptical or oblong or lanceolate, ascending or strongly reflexed, either puberulent and canescent upon the upper surface, or glabrate, usually acuminate, their margins more or less ciliate; calyces tubular, 13–15-veined, the mouth somewhat oblique, the teeth deltoid or narrowly deltoid to subulate or aristate, the base always deltoid; corolla tube longer than the lips, slender, abruptly expanded in the upper part to a funnel-shaped throat, hairy within and on the palate, the upper lip galeate, notched, strongly arched over the lower, the lower lip usually shorter but appearing longer by reason of the ample throat, three-lobed, the middle lobe longest; stamens seated in the throat, included in the galea or somewhat exserted, the filaments glabrous or hispidulous, the anthers attached at the side of the connective; style hispidulous, shortly exserted, the posterior lobe shorter.

The section *Cheilyctis* is readily separable into two series which I have named *Foliosae* and *Aristatae*. It is evident even

upon casual study that these series are closely allied and indubitably of common ancestry. While some members from each series are known to occur together, I have seen no evidence of hybridization between the two series.

Speciation has progressed further in *Aristatae* than in *Foliosae* and the segregates are more clearly defined geographically. It is significant that the former occupies a more broken terrain where isolation has had greater opportunity to play a part. It is further significant that the least differentiated elements within it, namely *M. pectinata* and *M. clinopodioides,* occupy the least differentiated territory. I am of the opinion that this section allies *Monarda* to *Glechon,* a Brazilian genus.

As previously,[1] I have employed the category subspecies to designate an emergent or incipient species, that is, a complex of one or more biotypes which has a characteristic regional distribution but which merges geographically and morphologically with allied subspecies in such a way as to render specific recognition uncertain or impracticable. These subspecies are probably ecotypes in the sense of Türesson.

Key to the Species

1. Calyx teeth prevailingly deltoid, their breadth usually half their length or more.	
2. Leaves rarely as narrow as 3 mm.	1. *M. punctata*
2. Leaves 1–3 mm. wide, canescent with minute hairs	2. *M. fruticulosa*
1. Calyx teeth subulate or aristate, their breadth usually much less than half their length.	
2. Bracts minutely but densely puberulent upon the upper surfaces at least below the middle, either whitish or purple; margins ciliate only towards the base.	
3. Bracts subfoliar, widest near the middle or above, acuminate but not aristate, forming a foliaceous involucre.	
4. Leaves subtending the glomerules 10–20 mm. broad at the base; Mexican species	3. *M. mexicana*
4. Leaves subtending the glomerules infrequently wider than 10–12 mm.; species of the United States	1. *M. punctata*
3. Bracts oblong or lanceolate, clearly differentiated from the leaves and usually ending in a bristle.	
4. Bracts oblong, prevailingly 3–5 mm. broad or more, abruptly narrowed to a short bristle; calyx tubes mostly 8–9 mm. long, their teeth mostly 3–5 mm. long	4. *M. citriodora*

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[1] Epling, C. Monograph of the Genus Monardella. Annals Mo. Bot. Gard. 12: 1–106, 1925.

4. Bracts oblong-lanceolate, strongly reflexed at maturity, prevailingly 1.5–3 mm. broad, gradually acuminate; calyx tubes mostly 5–6 mm. long, their teeth mostly 2.5–3 mm. long . . . . 5. *M. austromontana*

2. Bracts glabrous on the upper surface or essentially so, three to five or seven veins prominent, the intervenous tissue tending to be translucent; margins regularly ciliate-pectinate most of their length.

3. Calyx teeth 2.5–3 mm., rarely 4 mm. long; bracts usually with three veins prominent; corolla tube commonly 10–12 mm. long . . . . 6. *M. pectinata*

3. Calyx teeth 2.5–6 mm. long, mostly 3.5–5 mm., bracts usually with 5 or 7 veins prominent; corolla tube commonly 12–14 mm. long . . . . 7. *M. clinopodioides*

SUBSECTION FOLIOSAE

Calyx teeth deltoid, rarely subulate, their width infrequently less than half their length, usually more, commonly nearly equal to it.

1. Monarda punctata L. Sp. Pl. 22, 1753. Standard specimen:[2] that plant of the Linnean Herbarium labelled "flor. verticill. hort. cliff. 495."

Perennial or annual herbs, usually of sandy soil, 20–100 cm. tall or more, usually erect, shortly decumbent at the base thus forming a short rhizome, or perennial from the crown, prevailingly branched in the upper axils, the branches ascending, less often branched at the base, the branches erect, in any case pubescent, either with short curving appressed hairs with which in some forms longer, coarser hairs occur, or sometimes clothed with short spreading hairs, even becoming canescent; leaves variable, mostly 3–10 cm. long, .3–2 cm. wide, prevailingly oblong-lanceolate, frequently oblong, linear-lanceolate in one subspecies, either acute or obtuse at the apex, narrowed at the base to a petiole usually less than the breadth, their margins irregularly serrulate or subentire, the upper surfaces glabrous or pubescent with short hairs, the lower usually woolly along the midvein, in some cases throughout, even becoming canescent and subtomentose, infrequently nearly glabrous; bracts purple or yellowish-white, rarely white, subfoliar, acute or acuminate, entire, puberulent or sometimes pubescent, usually with a few cilia on the margin toward the base; calyces prevailingly 6–8 mm. long, their teeth variable on the same plant, *not often longer than the width of the calyx tube, narrowly deltoid,* acute or acuminate, infrequently as broad as long, their margins naked or ciliate, the orifice provided to some degree with similar hairs; corolla purple- or brown-punctate on the lips, commonly yellow

[2] Epling, C. Jour. Bot. (Br) 67: 3, 1929.

or yellowish, less often white, rarely pure white and unspotted, apparently rose-colored in extreme western forms, 14–25 mm. long, the lips subequal, the tube 8–14 mm. long, very slender and equal within the calyx, abruptly expanded to a funnel-form throat 2.5–6 mm. long, the palate of which is beset with blunt thick trichomes; filaments and style usually hispidulous; nutlets smooth.

While I believe that the species is in the process of fragmentation, the geographical races are contiguous and are hardly of sufficient definition to justify more than subspecific segregation. It is possible that an extended field survey, particularly after a study of floral structure and proportion, might lead to another opinion; I believe not.

Key to the Subspecies

1. Leaves pubescent over the entire lower surface or nearly so; stems pubescent with short often spreading hairs; corolla tube 9–12 mm., prevailingly 10–11 mm. long, the throat 3.5–4 mm. long; plants of the Middle West, rare in Texas ...... 1b. subsp. *villicaulis*
1. Leaves glabrate or puberulent throughout on the lower surface or, if pubescent, the pubescence confined largely to the middle of the leaf; stems puberulent with small curving hairs which are mostly appressed, rarely bearing longer coarser hairs in addition.
    2. Corolla 17–25 mm. long, mostly 22–24 mm. long, the tube mostly 12 mm. long or more; plants of the Atlantic and Gulf seaboards 1a. subsp. *typica*
    2. Corolla 14–20 mm. long, mostly 15–18 mm. long, the tube usually less than 12 mm.
        3. Plants prevailingly perennial, 50–100 cm. tall, rarely less, branching in the upper axils; calyx teeth narrowly deltoid, often acuminate, sometimes subulate; Texan plants .... 1c. subsp. *Stanfieldii*
        3. Plants annual, 20–50 cm. tall, branching at the base; calyx teeth typically broadly deltoid, often obtuse; range from Kansas to Oklahoma and Texas and southwest .... 1d. subsp. *occidentalis*

1a. Monarda punctata subsp. **typica** nom. nov. Based upon the standard specimen of the species which is conspecific with and similar to *Biltmore Herb. 653a* collected near Chimney Rock, N. C.

M. lutea Michx. Fl. Bor. Am. 1: 16, 1803. Based upon a specimen collected by Michaux now in the herbarium of the Jardin des Plantes, Paris.

Perennial (very rarely annual), sometimes forming a subshrub in the extreme southern portion of its range; stems puberulent with short recurved hairs and *frequently sprinkled with longer*

stiffish hairs; leaves prevailingly 3–5 cm. long, 8–15 mm. wide along the Atlantic and Gulf seaboards, increasing to 8–10 cm. in southwestern Arkansas and adjacent Texas, *sparingly pubescent beneath,* rarely incanescent along the midvein, sometimes nearly glabrous, the margins tending to be entire; bracts commonly purple; corolla yellow with purple spots, very rarely white and unspotted, 17–25 mm. long, *commonly 22–24 mm.,* the tube 11–14 mm., prevailingly 11–12 mm. long, the throat *4–6 mm.* long.

Ranges from New Jersey south to Florida thence west to Louisiana, Arkansas and eastern Texas. Along the seaboard, the leaves are prevailingly 3–5 cm. long; a form in central and southwestern Arkansas has leaves 6–8 cm. long or more and passes into subsp. *villicaulis.* The form with longer trichomes occurs throughout this range, but appears to be more abundant in the south. Specimens from Pelican Key and Corpus Christi, Texas, are very hairy and suggest a more robust plant woody at the base. Forms in the vicinity of Dallas and Fort Worth, Texas, suggest transitions to subsp. *Stanfieldii.* Forms from New Jersey suggest transitions to subsp. *villicaulis.* As a rule the leaves of subsp. *typica* become less pubescent in the southern part of its range.

1b. Monarda punctata subsp. **villicaulis** (Pennell) comb. nov. Based upon *M. punctata* var. *villicaulis* Pennell (Bull. Torr. Bot. Club 46: 186, 1919), which is based upon a specimen collected by Pennell (no. 6412) in Indiana (Lake Co.) near Clarke; the type is in the herbarium of the New York Botanical Garden.

M. punctata var. *lasiodonta* Gray, Syn. Fl. N. Am. 2^1: 375, 1886. Based upon a specimen collected in Texas by Drummond; the type is in the Gray Herbarium. This variety was based primarily upon Drummond's two specimens, but there were included fragmentary specimens of Hall (subsp. *Stanfieldii*), Woodhouse (subsp. *occidentalis*), and Wislizenus (subsp. *occidentalis*).

M. lasiodonta Small, Fl. S. E. United States 1038, 1337, 1903. Based upon the above named variety.

Perennial herbs mostly of sandy places, their stems usually 50–60 cm. tall, often branched from the base, more or less densely pubescent with short, often spreading hairs; leaves commonly 4–6 cm. long, *pubescent over the whole of the lower surface,* densely so along the midrib, sometimes canescent and subtomentose, the blades thicker than the typical subspecies and with petioles which are usually shorter than the breadth of the blade; bracts yellowish rather than purple; calyx mostly 7–8 mm. long, the teeth commonly ciliate; corolla yellow, spotted with purple, prevailingly *17–18 mm. long,* the tube 9–12 mm., mostly *10–11 mm. long,* the throat 3.5–4 mm. long.

Typically developed in sand dunes around the southern end of Lake Michigan, occurring also in the Mississippi and Ohio River Valleys, apparently on sand-bars or in sandy waste places. Some forms verge closely to subsp. *typica.* Occasional plants occur also in Oklahoma.

1c. Monarda punctata subsp. **Stanfieldii** (Small) comb. nov. Based upon *M. Stanfieldii* Small, Fl. S. E. United States, ed. 1, 1038, 1903, which was based upon a fragmentary specimen collected by Stanfield near San Marcos, Texas, in 1897; type now in the herbarium of the New York Botanical Garden.

M. punctata var. *immaculata* Penn. Bull. Torr. Bot. Club 46: 187, 1919. Based upon a specimen collected by Pennell (no. 5494) in Texas (Victoria Co.) near Aloe; the type is in the herbarium of the New York Botanical Garden.

Perennial (or annual ?) herbs mostly 50–100 cm. tall, their stems cinereous-puberulent with recurved hairs; leaves glabrate on the upper surface, *puberulent or glabrous beneath,* 4–6 cm. long, usually sharply serrate, the petioles commonly ciliate at the base; calyx teeth *narrowly* deltoid, sometimes approaching subulate, very acute or acuminate, more or less ciliate; corolla yellowish or white but usually spotted, 15–20 mm. long, variable in size, the lips usually shorter in proportion to the length of the slender tube than in the other subspecies, the upper lip more markedly curved, the tube 9–12 mm. long, the throat 2.5–3.5 mm. long.

Ranges from the northeastern corner of Texas southwestward to the Rio Grande. Forms near Dallas and Fort Worth suggest intermediate forms with subsp. *typica.* May be distinguished from subsp. *occidentalis* chiefly by the habit. *M. punctata* var. *immaculata* is a form 30–45 cm. tall with linear-lanceolate leaves 3–4 mm. broad which is found in a small area within the range of subsp. *Stanfieldii.* It is known from only a few specimens and I believe will prove to be only a depauperate form of that subspecies.

1d. Monarda punctata subsp. **occidentalis** subsp. nov. Based upon a specimen collected in Oklahoma in sandy places near Alva by Stevens (no. 3072); the type is in the herbarium of the New York Botanical Garden; an isotype is in the Gray Herbarium.

Plantae annuae altitudine 20–50 cm. plerumque e basi ramosae, cinereo-puberulae; foliis plerumque 3–4 cm. longis, paginis ambobus tenuiter puberulis vel glabris; bracteis flavidis vel etiam albis, rarius purpureis; calyce vulgo 6 mm. longo, dentibus maximam partem deltoideis et valde ciliatis, pilis argenteis, ita glomerulis maturis compactis nitentibus; corollis flavidis vel albis (? vel purpureis) plerumque maculatis 14–20 mm. longis, vulgo 15–16 mm.; tubis 8–11 mm. longis, vulgo 8–9 mm.; faucibus 2.5–3.5 mm. longis.

Ranges from central Kansas southward through western Oklahoma to central Texas. Occasional plants also occur in Missouri near Kansas City, in the Organ Mts. and at San Lorenzo, New Mexico, and in Chihuahua. The New Mexican and Mexican forms appear to have rose-purple corollas spotted with deeper purple. They are too little known.

2. **Monarda fruticulosa** sp. nov. per specim. in Texas prope Peña Station a Havard lectum constituta est; typum in herb. Smithson. vidi.

Herbae perennes altitudine 30–40 cm., videtur in basi suffruticosae habitu fruticuli utrimque ramosae cortice discedente *ramulis pilis minutis appressis canescentibus;* foliis *linearibus fasciculatis 1–1.3 cm. longis,* 1–3 mm. latis, integris vel sparse dentatis, acutis, in basi angustatis subsessilibus; glomerulis 1.5–2 cm. diametro bracteis ovatis vel ellipticis interdum subrotundis integris abrupte acuminatis ad basim ciliatis canescentibus rarius purpurascentibus; calycibus 5–7 mm. longis puberulis, dentibus anguste deltoideis vel subulatis acutis 1 mm. longis villosis; corollis lutescentibus videtur immaculatis 10–16 mm. longis, tubis 8.5–10 mm. longis, faucibus anguste infundibuliformibus intus pubescentibus; antheris vix exsertis; stylo et filamentis hispidulis.

Distribution: Texas: Duval Co.: Peña Sta., 21, VIII, 1888, *Pringle;* Peña Sta., 1889, *Nealley 386;* Peña Sta., IX, 1884, *Havard,* type; between Hebronville and Alice, 21, VI, 1925, *Tharp 3713;* Torrecillas, 24, V, 1904, *Griffiths 6422.*

SUBSECTION ARISTATAE

Calyx teeth subulate to aristate.

Speciation within this series has proceeded further than in the first and the segregates have much more weight. The degree of variation within the species here recognized and the degree to which they occasionally approximate one or the other of their allies suggest that speciation is incomplete. Nevertheless, since they are isolated for the greater part and since most of the plants examined fall readily into the categories here described, I have preferred to consider them as species. As far as one may ascertain from preserved material there is no single criterion used as a means of segregation which is not found to some degree in one or the other of the allies. Nevertheless, a form of one geographical region is never duplicated in another region. The intermediates are not necessarily intermediate geographically.

3. **Monarda mexicana** sp. nov. per specim. in Mexico prov. Durango a Garcia (no. 399) lectum constituta est; typum in herb. Smithson. vidi.

Herba ut videtur annua altitudine 35–40 cm., caulibus superne pubescentibus; foliorum laminis mediis lanceolatis 4–6 cm.

longis, 10–12 mm. latis acutis vel acuminatis, in basi ad petiolos 5–6 mm. longos rotundato-angustatis, margine subintegra, paginis ambobus viridibus glabris, supremis majoribus sessilibus patentim acuminatis; verticillastris in foliorum supremorum axillis dispositis bracteis *subfoliosis subrotundis* acuminatis involucratis superne infra medium purpureo-puberulis subtentis; calycum tubis 6.5–7 mm. longis 15-venis glabris, dentibus subulatis acutissimis 1.5 mm. longis villosis; corollarum albarum rubropunctatarum tubis 10–11 mm. longis, intus pubescentibus, faucibus infundibuliformibus 3.5–4 mm. longis, labia superiore circa 10 mm. longa arcuata, inferiore subaequilonga; staminibus breviter exsertis; stylo hispidulo.

Known only from the State of Durango; type, *Garcia 399.* While the corolla and genitalia are those of *Cheilyctis,* the habit of its foliage and bracts and the habit of the calyx teeth strongly suggest *Eumonarda,*

4. Monarda citriodora Cerv. ex Lagasca, Gen. et Sp. Nov. 2, 1816. Based upon a garden specimen reared from seeds sent two years previously by Cervantes; the type or authentic material may be at Madrid. I have based my nomenclature upon two plants distributed by Pavon, one preserved in the Boissier Herbarium at Geneva, the other in the British Museum. I have seen no other Pavon specimens of *Monarda* and believe it highly probable that these represent authentic material. The same view was held by Asa Gray who thus annotated the specimen in the Boissier Herbarium. The specimens are nearly identical and are similar to specimens collected at Monterrey, Nuevo Leon. It seems much more probable that at that date plants from Monterrey rather than from the little known interior should have found their way to Spain.

M. tenuiaristata Small, Fl. S. E. United States 1038, 1903. Based upon *M. citriodora* var. *tenuiaristata* Gray, a name not properly published; authentic specimens collected by Lindheimer (no. 497) are in the Gray Herbarium; Lindheimer no. 153 and a garden specimen are in the Torrey Herbarium.

M. dispersa Small, Fl. S. E. United States 1038, 1903. Based upon a specimen collected in Missouri near Eagle Rock by Bush (no. 122); type in the herbarium of the New York Botanical Garden.

M. aristata Nutt. Trans. Am. Phil. Soc. 5: 186, 1837. Based upon a specimen collected in "Arkansa" by Nuttall; the type is in the British Museum; probable isotypes are in the herbaria of the New York Botanical Garden, the Academy of Natural Sciences of Philadelphia and the Gray Herbarium; while volume 5 referred to bears the date of 1837, that portion containing Nuttall's paper, which was read in 1834, was actually distributed prior to 1836.

Erect annual herbs 15–90 cm. tall, commonly 40–60 cm.,

their stems commonly solitary or a few from a woody base, often virgate, frequently branched in the upper axils and forming a corymbose inflorescence, less often branched throughout, puberulent with minute appressed hairs; leaves narrowly elliptical or nearly linear to oblong or even oblanceolate, prevailingly 4–6 cm. long, 8–12 mm. wide, acute or obtuse, tapering at the base to a petiole 3–10 mm. long, their margins serrate or subentire, both surfaces glabrate, sparingly puberulent; heads 2.5–5 cm. broad, tending to be crowded, their bracts *spreading,* numerous, *forming a bowl-shaped involucre,* typically oblong, *3–6 mm. broad,* abruptly narrowed to a slender awn, green on the lower surface, three parallel veins usually prominent, *minutely but densely puberulent on the upper surface and whitish or purple,* entire or rarely denticulate near the apex, usually ciliate near the base; calyx tubes 8–11 mm. long, mostly *8–9 mm.,* finely puberulent, their teeth aristate, 2–8 mm. long, *commonly 3–5 mm.,* usually bearing a few bristle-like hairs in the upper parts; corolla white, lavender or rose color, usually unspotted, or the throat yellowish and flecked with red, 15–28 mm. long, the lips subequal, the tube 10–18 mm. long, pubescent within, somewhat less than twice the length of the upper lip, abruptly widened to the ample broadly funnel-form throat which is pubescent in the palate, 3.5–8 mm. long, the upper lip incised 1.5–2 mm.; stamens included, glabrous, the style glabrous or hispidulous.

Ranges from central Kansas southward through Oklahoma and Texas to Monterrey, Nuevo Leon, Saltillo, Coahuila, and Chihuahua, often in association with limestone. Its occurrence in Illinois, Tennessee, Missouri (except the extreme southwestern corner), Alabama, Georgia, and Florida is probably adventive. Its range is mostly below 2,000 feet elevation. Save for the variation in stature and size of the flowers, the species is fairly uniform. The bracts vary somewhat to elliptical and thus suggest *M. pectinata,* or to lanceolate and thus suggest *M. austromontana,* but are not reflexed. Some forms suggest mixture with *M. pectinata.* It frequently occurs in company with *M. punctata* subsp. *Stanfieldii. M. dispersa* is a large flowered form.

5. **Monarda austromontana** sp. nov. per specim. in Mexico in Chihuahua in umbrosis montis prope Cusihuiriachic La Bufa dicti a Pringle (no. 1355) lectum constituta est; typum in herb. Smithson.; isotypos in herb. horti bot. Nov. Eborac., et Field. Mus. vidi.

Herba annua gracilis erecta altitudine 15–80 cm., plerumque 30–50 cm., caulibus virgatis vel saepius e basi ramosis, pilis minutis appressis puberulis; foliorum laminis anguste ellipticis interdum oblongis, maximam partem 3–5 cm. longis, 8–12 mm. latis, rarius 1.5 cm. latis, in apice acutis vel obtusis, in basi ad petiolos 3–15 mm. longos angustatis, marginibus subserratis

rarius subintegris, paginis ambobus glabratis, sparse puberulis rarius pilis minutis canescentibus; glomerulis *2.5–3 cm. latis,* plerumque remotis, saepius inter se 2–6 cm. distantibus, *bracteis in maturitate valde deflexis,* exterioribus quam folia plerumque longioribus, mediis saepius *2–3 mm.* latis, oblongo-lanceolatis in aristam brevem acuminato-extenuatis, *vena media solum prominula,* pagina superiore puberula vel albida vel purpurea, marginibus ciliatis integris; calycum tubis 4.5–6.5 mm. longis, *plerumque 5–6 mm. longis,* sparse puberulis saepe glabris, dentibus aristatis, 1.5–4 mm. longis, plerumque *2.5–3 mm. longis,* maximam partem pilis extensis strictis paucis ad apices ornatis; corollarum albarum rarius rosearum saepius immaculatarum tubis 9–13 mm. longis intus pubescentibus, in fauces amplos 3.5–6 mm. longos abrupte dilatatis, labia superiore incisa 1–1.5 mm.; staminibus inclusis; stylo vel glabro vel hispidulo.

Ranges from the mountains of southeastern Arizona and southwestern New Mexico at elevations of 6,000–9,000 feet, southward in the Sierra Madre into the State of Durango to the valley of the Nazos. The forms within the United States are readily distinguished from *M. citriodora* in habit of the whole and of the inflorescence. The specimens of Chihuahua and Durango approach more nearly the Mexican forms of *M. citriodora* but apparently retain the differences in flower size. As a rule they may be distinguished also by the more hairy calyces of *M. austromontana.* Further exploration may prove the desirability of uniting these species.

6. Monarda pectinata Nutt. Journ. Acad. Phila. ser. 2, 1: 182, 1847. Based upon a plant collected by Gambel "near Santa Fe," New Mexico; the probable type is at Kew; no authentic specimens were found at the British Museum. Each of the two fragments at Kew bears a characteristic Nuttall label, one being attributed to "Sta. Fee" and the other to "Upper California." It is impossible to determine to which each label pertains. Both are similar and are very like *Baker, Earle and Tracy no. 614.* I consider these specimens the types. An authentic specimen sent by Durand to Gray is in the Gray Herbarium.

M. punctata var. *humilis* Torrey in Sitgreaves, Report of an Expedition down the Zuni and Colorado Rivers, 166, 1853, based upon a specimen collected by Woodhouse on the Zuni River on the Zuni Reservation, New Mexico; the type is in the herbarium of the New York Botanical Garden.

M. Nuttallii A. Nelson, Bot. Gaz. 31: 397, 1901. Based upon specimens collected in Colorado by *Crandall, Holzinger, Ramaley 166, Baker, Earle and Tracy 614* and *Hall and Harbour 428.*

Annual herbs 10–55 cm. tall, commonly 25–40 cm., usually much branched at the base, their stems puberulent with short curved hairs; leaf-blades oblong or elliptical, sometimes wider above the middle, commonly 2–4 cm. long, serrate and appar-

ently crisped or often subentire, nearly glabrous, on petioles 3–10 mm. long; heads commonly 2–3 cm. broad, tending to become globose at maturity, their bracts ascending, elliptical-oblong, usually green, commonly 2.5–4 mm. broad, tapering at the apex to an acumination less than the width of the bract, usually entire, regularly ciliate-pectinate most of their length, puberulent on the lower surface, usually *glabrous on the upper, with only 3 veins* prominently developed, but particularly the midrib, the intervenous tissue tending to be translucent; calyx tube 5.5–8 mm. long, commonly 6–7 mm., hispidulous with short hairs scarcely wider than the ribs, their teeth very slender and very acute, commonly *2.5–3 mm., rarely 4 mm. long,* ciliate; corollas white or lavender, 13–22 mm. long, commonly 14–16 mm., their tubes 8.5–12.5 mm. long, commonly 10–12 mm., the throat broadly funnel-form, 4–5 mm. long; stamens included, glabrous; style hispidulous.

Ranges through the sandhills of Nebraska southwestward through central Colorado into northern Arizona and through New Mexico to the extreme eastern parts of Texas.[3] Some plants collected in the Texas Panhandle suggest transitions to *M. clinopodioides*. The ranges of the two species overlap in that region.

7. Monarda clinopodioides Gray, Syn. Fl. N. Am. 2: 375, 1878. Based upon specimens collected in Texas by Drummond, Wright, and Reverchon (near Dallas in June, 1874); these are in the Gray Herbarium; I consider Reverchon's specimens to be the standard.

M. aristata Hooker, Bot. Mag. pl. 3526, 1836. Based upon a garden specimen from seed collected in Texas by Drummond, and erroneously ascribed to *M. aristata* Nuttall, Trans. Am. Phil. Soc. 5: 186, 1937, a paper which was read in April, 1834, and actually distributed prior to Hooker's publication, although volume 5 of the Transactions bears the later date of 1837.

M. penicillata Gray, Am. Acad. 8: 369, 1873 (nomen nudum).

Annual herbs 15–50 cm. tall, commonly 30–40 cm., commonly virgate, often branched above, less often from the base, their stems puberulent with short curved hairs; leaf-blades commonly 3–5 cm. long, oblong or elliptical, sharply serrate, nearly glabrous, on petioles 5–15 mm. long; heads commonly 2.5–3 cm. broad, their bracts ascending, elliptical-oblong, the outer tending to be ovate, usually tinged with purple, commonly 3–5 mm. broad, tapering at the apex to a sharp *rigid* acumination which is often as long as the width of the bract, puberulent on the lower surface, usually *glabrous on the upper, with usually 5, sometimes 7 veins* prominently developed, the intervenous tissue tending to be

[3] Since the above was written this species has been collected in California in the New York Mountains.

translucent, regularly ciliate-pectinate most of their length; calyx tube 6–9 mm. long, commonly 7–8 mm., usually hispid with hairs similar to those on the teeth but shorter, less often hispidulous, their teeth slender, very acute, *tending to be rigid and erect,* 2.5–6.5 mm. long, *commonly 3.5–5 mm. long,* ciliate; corollas white or lavender, 13–22 mm. long, commonly 18–20 mm., their tubes 10–15 mm. long, commonly 12–14 mm., the throat broadly funnel-form, 5–6 mm. long; stamens included, glabrous, the style hispidulous.

Ranges throughout central Texas westward into the Panhandle where it comes in contact with *M. pectinata,* and northward through central Oklahoma to the extreme south central part of Kansas (Harper and Kingman counties).

University of California at Los Angeles, July, 1934.

A NEW SPECIES OF CASTILLEIA

L. F. Henderson

Castilleia Andrewsii Henderson, sp. nov. Planta 15–30 cm. alta, curvata, etiam sinuosa, infra glabra, supra pilosa, purpureofulva; folia 20–40 mm. longa, trinervata, basi integra, cetera tripartita, lobis iterum tri-partitis, interdum purpurantia; calycis lobis tubo aequis, dentatis vel partitis, lobis ultimis lanceolatis; corolla 2–3.5 cm. longa, galea tubo multo longitudine excedens; labium maxime varians, lobis interdum longis, lanceolatis, erectis, subrufis; interdum incurvis, viridibus, sed erectis.

This is one of the most peculiar Castilleias it has ever been my privilege to see. It certainly has the look of *C. rupicola* Piper, but differs radically from that species, in its peculiarly irregular leaves, in its galea always longer than the tube, but most of all in its lip. This is so variable on different specimens as to make one doubt its diagnostic value in separation of species. Sometimes the lobes are long, lanceolate, upright and of a brownish-red color; sometimes they are shorter and upright, with a yellowish color; on two shoots they were greenish, incurved at sides, but upright. Always, as far as these specimens go, they are all upright, not downwardly curved, and the central lobe is shorter than the two lateral ones. The galea is like that of many species, green-backed with scarlet edges.

I have taken pleasure in naming this unique species for its discoverer, Mr. Roy C. Andrews, who found it on Horsepasture Mt. in eastern Lane County, Oregon, at an elevation of approximately 5,000 feet (*R. C. Andrews 233,* June 19, 1934. Type in the University of Oregon Herbarium, Eugene). I have been informed by Professor Morton E. Peck, of Willamette University, Salem, Oregon, that he found, he is now sure, the same species near Detroit, Oregon, but that as far as he or I know, the species has not yet been published.

University of Oregon, October 30, 1934.

PROCEEDINGS OF THE CALIFORNIA BOTANICAL SOCIETY

A meeting was held Thursday, October 25, 1934, in Room 2093, Life Sciences Building, University of California, Berkeley. Speaker: Mr. Rodney Ellsworth. Subject: New Light on the Discovery of the Calaveras Big Trees.

A meeting was held Thursday, November 22, 1934, in Room 2093, Life Sciences Building, University of California, Berkeley. Speaker: Mr. A. E. Wieslander, California Forest Experiment Station. Subject: The Vegetative Type Map.

On February 1, 1934, the Council of the California Botanical Society voted to accept the resignation of Dr. W. L. Jepson as editor of Madroño. It was decided, however, that Dr. Jepson be asked to continue as editor until the publication of the closing issue of volume 2. It was further decided that the editorial duties should then devolve upon a board of five members appointed by the president of the Society.

During the year 1934 the following names were added to the membership roll of the Society: Dr. L. H. Bailey, Ithaca, New York; Mrs. Virginia Bailey, University of California, Berkeley; Dr. L. R. Blinks, Stanford University; Dr. W. S. Cooper, University of Minnesota; Mr. Paul Covel, Oakland; Mrs. Hilda Grinnell, Berkeley; Dr. Joseph Grinnell, Berkeley; Professor D. R. Hoagland, Department of Botany, University of California; Mr. J. Wendell Howe, State College, Arcata; Mr. Gordon MacKinney, Carnegie Institution Laboratory, Stanford University; Mr. Leslie Mayne, Burlingame; Mrs. Kenneth Saunders, Berkeley; Mrs. Helen Sharsmith, Department of Botany, University of California, Berkeley; Professor H. W. Shepherd, Landscape Design, University of California, Berkeley; Mr. Joseph Stacey, San Francisco; Mr. Leo Whitney, U. S. Forest Service, Susanville; Mr. A. E. Wieslander, California Forest Experiment Station, University of California, Berkeley; Dr. H. S. Yates, California Forest Experiment Station, University of California, Berkeley.—E. Crum, Secretary.

NOTES AND NEWS

The Type Map Herbarium of the California Forest and Range Experiment Station has been moved to new quarters on the fifth floor of the University Herbarium, in the Life Sciences Building, University of California, Berkeley. Office space for Dr. H. S. Yates, in charge of the Type Map Herbarium, and for his assistants has also been provided on this floor. The Type Map Herbarium is maintained in connection with the mapping of the vegetation of the state, a project which is being directed by Mr. A. E. Wieslander.

THE ANATOMY OF CERCIDIUM TORREYANUM AND PARKINSONIA MICROPHYLLA

Flora Murray Scott

The palo verdes, *Cercidium Torreyanum* and *Parkinsonia microphylla,*[1] are small trees, common in the sandy washes of the southwestern deserts. Typically xerophytic, they appear in leaf only for a short time in early summer, but later in the season, although the branches are leafless, the trees are still conspicuous by the vivid greenness to which they owe their common name.

When working on the lignification of the xylem fibres of *Parkinsonia,*[2] I was unable to find in literature any connected, detailed account of the structure either of *Parkinsonia,* or of the closely related genus *Cercidium,* and I have therefore outlined the salient anatomical features of these two typical southwestern forms.

Cercidium Torreyanum (Wats.) Sarg.

Examination of a transverse section of the stem of *Cercidium Torreyanum* (pl. I, fig. 3) reveals such generally accepted xerophytic characters as heavily cutinised epidermis, sunken stomata, hypodermal water-storage layer, cortical chlorenchyma, abundance of oil-containing idioblasts throughout the parenchyma, and strong development of fibres in the vascular cylinder. The various tissues in the stem and the root will first be considered in detail. Thereafter the anatomy of the leaf and the seedling will be briefly outlined.

Stem. In the young stem the epidermis is one cell deep, and the cells are heavily cutinised. Hairs, generally unicellular, are present on the youngest stems. The cells retain the power of division and the epidermis increases in circumference during secondary thickening. The cells also divide tangentially, and thus a multiple epidermis results in the older twigs. The cuticle appears cracked on the surface, but it remains nevertheless a continuous layer, due to the activity of the underlying epidermal cells.

The stomata are sunken, and are arranged in parallel vertical lines along the stem. The long axes of the stomata are at right angles to the axis of the stem. Projecting ridges of cutin, characteristic of xerophytes, protect the stomata. The layer of cutin may extend through the stomatal aperture and line the roof of the respiratory chamber (pl. I, figs. 1, 2). The epidermis remains as a living functional layer for many years, and

[1] Jepson, W. L., Manual of the Flowering Plants of California. 1925.
[2] Scott, F. M., Am. Journ. Bot. (in press).

Madroño, vol. 3, pp. 33–116, April 1, 1935.

cork formation, generally speaking, is confined to the older trees. Here and there, however, near the branch crotches, and elsewhere intermittently on the younger branches, perhaps in response to insect or other wound stimulus, isolated patches of cork may occur. The development of the cork begins, as usual, near a stoma, and in the process of cork formation the hypodermal cells are eventually sloughed off.

Beneath the epidermis lies a layer of hypodermal tissue, consisting of thin walled, unlignified, water containing cells, devoid of chloroplasts. This hypodermis is, in the young stem, one cell deep, but tangential division may take place later in some of the larger cells. The layer is interrupted at the stomata, and since the cells of the hypodermis vary in size, the hypoderm-chlorenchyma junction appears as a sinuous line (pl. I, fig. 3). The cells of the hypodermis in fresh material are clear and colorless, and appear to be filled with a mucilaginous material. Microchemical tests indicate also the presence of traces of sugar, oil, and of protein material.

Collenchyma is generally present in younger stems, but is not more than two or three cells thick.

The photosynthetic chlorenchyma is made up of several layers of palisade-like cells, with the usual intercellular spaces (pl. I, figs. 1, 2). Starch and oil are abundant throughout this tissue, the latter appearing to impregnate the chloroplasts, and being also distinguishable in the form of droplets of varying size in the protoplasm. The chlorenchyma is bounded on the inner face by a single layer of colorless cells, presumably containing water and mucilage, inside of which appears a heavy pericyclic ring of lignified elements, alternating groups of fibres and stone cells (pl. I, fig. 2). In the youngest stems the fibres alone are present.

In the parenchyma of *Cercidium,* including the hypodermis, calcium oxalate is abundant at various times throughout the year. It occurs generally in the form of large rosette crystals, but tabular crystals may also be observed. Tannin is noted occasionally in the same tissues.

The most striking feature in the vascular cylinder, at all seasons of the year, is the abundance of starch throughout the xylem. In young twigs the vascular bundles are separate, and later they are united in a continuous cylinder as in a typical woody dicotyledon. The component elements in the phloem are fibres, sieve tubes, with terminal and lateral sieve plates, companion cells, and a certain amount of phloem parenchyma. The xylem is made up of tracheal tubes, reticulate and border pitted, and of characteristic substitute fibres (pl. I, fig. 4, f_1, f_2). The medullary rays are as a rule one cell wide and from six to twenty cells high. The seasonal rings are well marked, since the few tracheal elements are laid down only at the beginning of the

growing period. It was noted that the growth rings are often somewhat asymmetric in the younger branches, but the distribution of this asymmetry has not been further investigated. The substitute fibres in *Parkinsonia* have been described in some detail by the writer,[2] and the fibres of *Cercidium* appear to be similar. During the active growing season, the cambium cuts off a series of xylem and phloem elements in the usual way, and the course of development of the xylem substitute fibres may easily be followed. Thickening of the cell wall is followed by lignification, and thereafter starch grains accumulate in the fibres, eventually blocking the lumen completely. The substitute fibres remain alive, and in some cases appear to be multinucleate. A very marked difference in wall thickness serves to distinguish spring and summer substitute fibres.

From the standpoint of causal anatomy a curious feature is the occurrence of a strand, crescent shaped in transverse section, of unlignified cells ensheathing the protoxylem tip of the vascular bundle. For reasons unknown this strand escapes the ubiquitous lignification which takes place not only in the xylem, but also in the central core of pith. The latter is composed of typical parenchyma, in which lie scattered groups of fibres. Both are completely lignified in relatively young twigs.

Root. The heavy development of cork in the older root is another typically xerophytic character seen in the anatomy of *Cercidium*. The component cells of the root tissues are similar to the corresponding elements already described in the stem. Characteristic, as before, are the starch containing substitute fibres which form the bulk of the solid xylem cylinder. The tracheal tubes, as is general in roots, are wider in lumen than those occurring in the stem. Oil is abundant in the cortical cells. The development of the root will be outlined below in the description of the anatomy of the seedling.

Seedling. The seed coat of *Cercidium Torreyanum,* like that of *Parkinsonia,* to be described in detail later, is extremely hard, but germination of the seeds may be speeded up by soaking them three to four hours in concentrated sulphuric acid, and washing thereafter overnight in running water. After such treatment the radicles appear as a rule within forty eight hours.

The seedlings were examined at various stages of growth, and the development of the vascular system, including the transition region, was traced. The accompanying diagrams of transverse sections of the axis, cut at various levels in a seedling 12.8 cm. long, serve to illustrate the main points (pl. I, figs. 5–10).

In a seedling at this stage the cotyledons are green and somewhat fleshy and the plumule is beginning to develop. The hypocotyl-root junction, in this case approximately coincident with

the transition region, is marked by a circular ridge. The epidermis and the surface layers of the cortex on the hypocotyl become suberised very early, in this differing from the surface of the developing plumule. Secondary roots appear at this time in the upper part of the root.

In regard to the anatomy of the young seedling, it may be seen that the tissues near the root tip are still undifferentiated. In the region of elongation, a procambial cylinder is defined, while further back, in the root hair zone, the differentiation of the vascular system and of the endodermis is apparent. The root is tetrarch, and the protoxylem elements, as in other similar roots, are laid down at the inner margin of the food conducting cylinder, constituting the "alternate phase" of development (pl. I, fig. 5). Passing upwards, lignification now extends tangentially, and a more or less complete cylinder of xylem thus arises, the "intermediate" phase, which is maintained up to the level of the root-hypocotyl ridge (pl. I, figs. 6, 7). At this point the additional metaxylem elements are perforce laid down outside the xylem cylinder, and the superposed phase of the typical stem is now realized (pl. I, fig. 8). This is accompanied, in a seedling of this size, by the usual separation of the vascular bundles, as they pass upward to the cotyledons and the developing plumule (pl. I, figs. 9, 10). At the level of development of the superposed phase, that is, in the transition region, the endodermis, typical of the root, comes to an end, and at the same time the development of the phloem fibres, typical of the stem of *Cercidium,* begin to appear (pl. I, figs. 7, 8).

It is thus seen that the seedling *Cercidium* resembles fundamentally the tetrarch seedlings of the widely divergent genera *Ricinus*[3] and *Chilopsis.*[4]

In *Cercidium,* an accessory endodermis is occasionally present in the developing root. The radial walls of this layer bear the usual very heavy thickenings, which appear in transverse section as semicircular ridges. The exact details of the occurrence or absence of this layer were not determined.

Leaf. The leaves, as already noted, appear after the winter rains and persist, as a rule, for a very short time. In them, as might be expected, xerophytic adaptations are not at all evident. The pinnae are rather thin, and consist of one or two layers of palisade, and three or four layers of spongy mesophyll tissue. Cuticle is present on the surface of the epidermal cells, but is not markedly thickened as in the stem. Stomata are present on both upper and lower surfaces of the leaflets, and the guard cells lie almost level with the surface. Hypodermal cells are

[3] Scott, F. M., and Sharsmith, H. H., Am. Journ. Bot. 20: 176–187. 1933.
[4] Scott, F. M., Am. Journ. Bot. (in press).

developed only beneath the midrib, and intermittently beneath the submarginal veins. These cells resemble the hypodermal cells of the stem, and like them may contain a certain amount of oil. Between the palisade and the spongy mesophyll tissue, thick-walled spherical idioblasts occur, clearly defined by their content of oil.

Parkinsonia microphylla Torr.

In general habit *Parkinsonia microphylla* differs from *Cercidium* in length of leaf, the rachis bearing from 15 to 25 pairs of leaflets, in contrast to the three or four pairs of the other genus. The leaflets are shed before the rachis, and the latter persists for a time as a functional photosynthetic organ. While no study has been made of the movements of leaflets of the two genera, a problem of undoubted ecological interest, it is observed that in *Parkinsonia* in cultivation the pulvini of the leaflets are actively functional, and the leaflets fold at night parallel to, and along the upper surface of the rachis.

The anatomy of the stem and root, of the seed coat, and of the leaf will be briefly outlined.

Stem. In structure the stem is essentially similar to the stem of *Cercidium,* with multiple epidermis, horizontal guard cells, xerophytic hypodermal layer, chlorenchyma, pericyclic fibres and stone cells, xylem consisting in the main of starch-containing substitute fibres and relatively few pitted or spiral tracheal tubes, and a pith in which scattered groups of fibres occur. Ergastic substances—starch, oil, tannin, and calcium oxalate—are likewise similar in occurrence.

Root. The anatomy of the root does not differ in any essential from that of *Cercidium.* The xerophytic layer of cork is equally developed in both genera.

Seedling. In regard to the seedling axis, the diagrams which illustrate the structure in *Cercidium* serve equally well to illustrate *Parkinsonia.*

Seed Coat. The structure of the seed coat also is similar in both the palo verdes. The seed coat, as has been indicated by the somewhat drastic treatment necessary to speed up germination, is extremely hard and is of highly complex structure. When a section of the ripe seed coat is cut, five layers may be distinguished, three of which are well defined, while the other two appear as crushed and insignificant tissue (pl. I, fig. 11). The protective outer coating is made up of columnar cells, thick-walled and heavily cutinised, particularly towards the inner border. A light line of unknown function is present and is indi-

cated in the figure (pl. I, fig. 11, i). This is followed by a lignified zone, ten to twenty cells deep, of fibres variously oriented. Oil is abundant in this tissue, as may be seen with the use of Sudan III. This stain also serves to delimit the third layer of the seed coat, a narrow zone of somewhat crushed and thin-walled cells, heavy staining of which gives the impression of a cuticular layer separating the fibrous layer from the underlying mucilage cells (pl. I, fig. 11, ii, iii, iv). The latter resemble mesophyll cells in their branched form, and in their loose grouping. Traces of oil are still obvious in the cell contents. During germination the mucilage layer expands enormously as the measurements in the diagram indicate. The walls very soon disintegrate into a formless mass. The innermost lining of the seed coat, layer five, consists of somewhat irregular crushed cells with slightly cutinised cell walls (pl. I, fig. 11, v).

Leaf. The rachis, as has been noted, bears a large number of deciduous leaflets, and as may be expected from this deciduous habit, no marked xerophytic characters are developed in the pinnules. In transverse section the leaflet differs from that of *Cercidium* mainly in the lack of the occasional spherical oil-containing idioblasts. The anatomy of the rachis and of the pulvinus are, however, distinctive features.

Three leaf traces enter the leaf base, but as they enter the pulvinus they merge to form an incomplete cylinder (pl. I, fig. 12). This flattens as it passes into the rachis, and gives off the numerous lateral veins which constitute the vascular supply of the leaflets. The pulvinus in transverse section is circular in outline, and, as usual in such structures, the vascular and the mechanical tissues are concentrated near the center of the axis. The mechanical sheath surrounding the vascular tissue in the pulvinus consists of thickened fibres with walls of cellulose while in the rachis the corresponding fibre walls are heavily lignified. Chlorenchyma tissue with rather thick walls forms the main bulk of the pulvinus tissue, bounded by a single layer of epidermal cells. No hypodermal tissue is present.

The flattened elliptical leaf-like outline of the rachis is evident in plate I, figure 13. The tissues are similar to those in the photosynthetic stem, although differing in the degree of development. Thus the multiple epidermis of the older stem is represented by a simple epidermis one cell thick, and the hypodermis likewise is only a single layer in depth. Stomata are present on both the upper and the lower surfaces, and the occurrence of palisade chlorenchyma on both surfaces produces a bifacial structure. The distribution of the vascular and the mechanical tissue in relation to the chlorenchyma and the central layer of mesophyll is illustrated in the diagram.

Summary and Conclusions

The palo verdes, *Cercidium Torreyanum* and *Parkinsonia microphylla,* similar in their general vegetative habit, are also strikingly similar in their typically xerophytic structure.

1. The stem in both is photosynthetic, and is characterised by a heavily cutinised epidermis, with sunken stomata transverse in position. Beneath the epidermis lies a large celled hypodermis, which, however, is interrupted opposite the stomata, so that the latter lead directly into the respiratory chambers, the intercellular spaces in the cortical chlorenchyma.

2. The usual ergastic substances, starch, an abundance of oil, and occasionally tannin, are present in these tissues. At certain times also calcium oxalate in the form of rosette crystals, or infrequently in the form of tabular crystals, fills practically the entire lumen of the hypodermal cells.

3. When the cork eventually develops in the older stem, it is subepidermal in origin; as it increases in thickness, the hypodermis sloughs off.

4. The vascular cylinder is delimited by a pericyclic ring of fibres and stone cells. The xylem is heavily lignified throughout, and is distinguished by the abundance of starch-containing substitute fibres.

5. As is the case in xerophytes generally, the root is protected by a well developed layer of cork; otherwise the only distinctive feature of the root appears to be the inconstant occurrence of a secondary endodermis.

6. In the seedling the development of the vascular system including the transition region follows the tetrarch pattern of *Ricinus* and *Chilopsis.*

7. It is only in the leaves of the two genera that marked anatomical differences occur. The leaflets, however, are essentially similar, in that they are deciduous in both, and do not possess any marked xerophytic characters. On the other hand, the rachis of *Parkinsonia,* with its conspicuous basal pulvinus and leaf-like photosynthetic structure, is distinctive. The fibrous sheath surrounding the vascular strand of the pulvinus consists of unlignified fibres, which grade into heavily lignified elements in the rachis.

A survey of the anatomy of the palo verdes thus raises certain points of interest in regard to the metabolism of these xerophytic forms. Seasonal growth, that is a period of active photosynthesis and food storage, is indicated by the occurrence of annual rings. Yet in the material examined at different times throughout the past two years, no significant variation in the amount of reserve starch was observed. Is this starch, then, to

be considered merely as unavailable excess material; or would it under more favorable conditions be utilised to an appreciable extent?

In addition to starch, oil is present as a reserve material, both in the protoplasts of the parenchyma cells, and impregnating the walls of xylem and phloem lignified elements. The actual content of oil and water of the living cells presumably varies from season to season, but whether this variation runs to the extent of a phase reversal in the colloidal system remains a question.

The conditions necessary for the extensive deposition of calcium oxalate in the hypodermal cells were not determined.

The intensive lignification of desert plants is well known, and implies, perhaps, that loss of water in the cell wall is at least one condition necessary for the process of lignification. The structure of the pulvinus and the adjacent rachis, where lignified and unlignified elements grade into each other, is therefore of interest from the standpoint of causal anatomy.

University of California at Los Angeles,
December, 1934.

Explanation of the Figures. Plate I

Cercidium Torreyanum

Fig. 1. Longitudinal section of stem, showing stoma and surrounding tissues: *c,* cuticle; *e,* epidermis; *h,* hypodermis; *s,* stoma; *r c,* respiratory chamber; *cr,* cortex (camera lucida, ×150).

Fig. 2. Transverse section of a similar stem: *g c,* guard cell; *p f,* phloem fibre (camera lucida, ×150).

Fig. 3. Transverse section of stem (diagrammatic), distribution of tissues: *ph,* phloem; *cm,* cambium; *x,* xylem; *pt,* pith; *pt f,* pith fibres.

Fig. 4. Transverse section xylem cambium junction (camera lucida, ×150): *m r,* medullary ray; *t t,* tracheal tube; f_1 and f_2, thickened and less thickened fibres.

Figs. 5 to 10. Transverse sections of the seedling axis at various levels showing the development of the vascular system and the transition region: *r h,* root hair; *end,* endodermis; *px,* protoxylem; *mx,* metaxylem; *f,* fibres.

Parkinsonia microphylla

Fig. 11. Transverse section of seed coat: layers i, ii, iii, iv, v (camera lucida, ×150). The measurements of the various layers are indicated in microns.

Figs. 12, 13. Transverse section of pulvinus and rachis, respectively: *s f c,* sheath of unlignified fibres; *s f l,* sheath of lignified fibres; *pal,* palisade; *v b,* vascular bundles; *mes,* mesophyll.

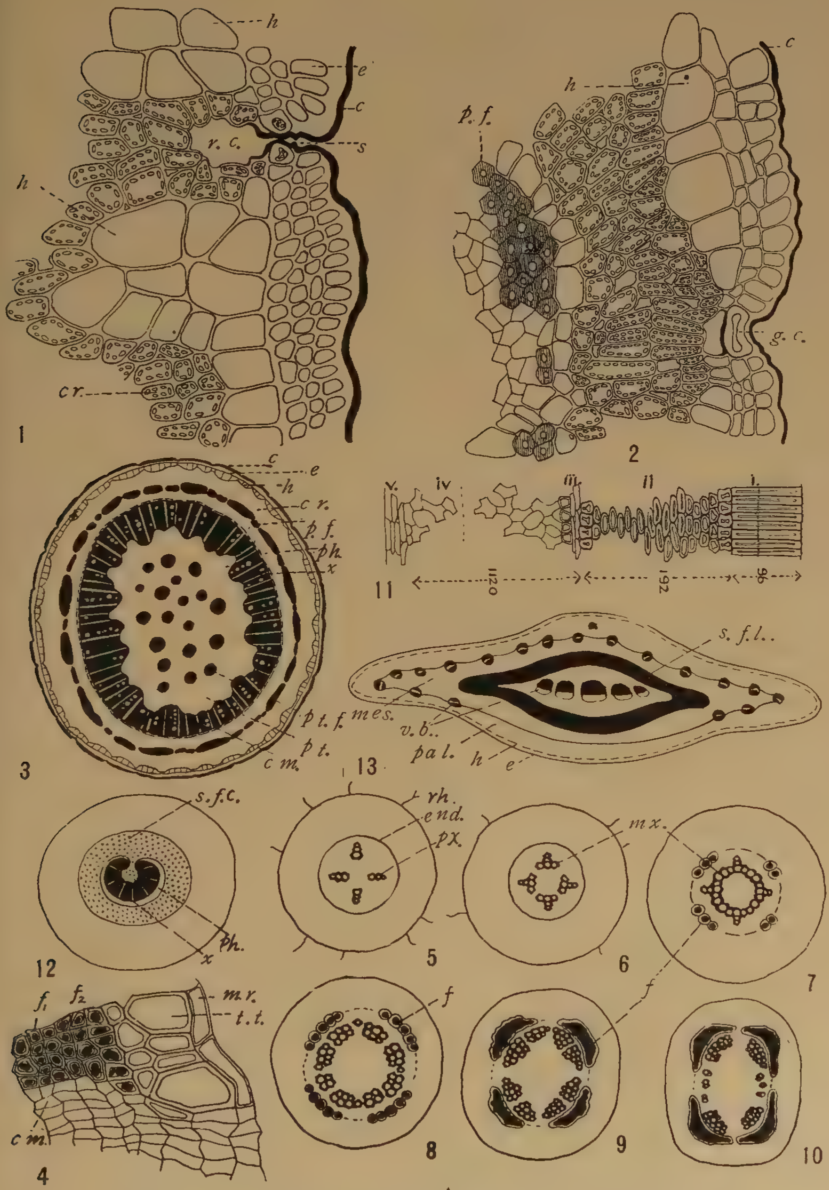

Plate I. Anatomy of Cercidium and Parkinsonia.

THE CALIFORNIA STATE DEPARTMENT OF AGRICULTURE

Herbert F. Copeland

The activities of the Department of Agriculture, State of California, are of concern to all inhabitants of the state, and are in some phases of particular interest to botanists.

The Department was created in 1919 by the fusion of several governmental agencies already in existence. The officer whose title had previously been State Commissioner of Horticulture became Director of Agriculture and head of the department. The Board of Agriculture, which served as board of directors of the State Agricultural Society, managed the State Fair, and exercised various other functions, was continued in existence. In 1929 the Board of Agriculture was limited to advisory functions, for the better performance of which it has been armed, since 1933, with power to conduct investigations. It consists at present of eight members appointed by the Governor for overlapping four-year terms, together with an annually appointed president.[1] The management of the State Fair was assigned to the State Department of Finance, acting through a "State Agricultural Society" appointed by the Governor.[2] The Department functioned, formerly, under the authority of many acts of the legislature; in 1933 most of these were assembled in a single measure, the Agricultural Code.

Under the Code, the Director is responsible for essentially all the activities of the Department. He holds office during the pleasure of the Governor and receives a salary of $6000 per annum. In practice, he acts through the many individuals who make up the personnel of the Department. He appoints the personnel, organizes subsidiary agencies, and assigns duties. As now organized, the department consists of an administrative staff together with six Divisions, respectively of Animal Industry, Plant Industry, Chemistry, Markets, Market Enforcement, and Weights and Measures. The larger Divisions, those of animal and plant industry, are subdivided into many agencies called "Bureaus" or "Services." The officers standing next to the Director, the Chiefs of Divisions, held office formerly at his pleasure; by a measure approved by the people at the recent election of November, 1934, they become members of the State

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[1] In the words of the Agricultural Code, section 40, ". . . The president of the board of directors of the State Agricultural Society shall be the ninth member and president of the State Board of Agriculture . . ." and section 71, ". . . The president of the board of directors of the State Agricultural Society shall be designated annually by the Governor."

[2] Agricultural Code, section 70. "The State Agriculture Society is a State institution within the Department of Finance, and consists of a board of directors of fourteen members."

Civil Service. All subordinate employees of the Department, Chiefs of Bureaus, assistants, experts, inspectors, etc., were and are members of the Civil Service.

The Department is described as a regulatory and service institution. After study of the Code and of annual reports, one is able to describe the activities of the Department in such terms as these: it suppresses nuisances and maintains commercial standards throughout the range of domestic non-human life. The word "domestic" seems best to describe the limit separating interests of this department from those of the Department of Natural Resources; it is the latter that is concerned with fish and game, and with forests. In more detail, the functions of the Department include the following:

It licenses and inspects dairies and all business establishments handling dairy products, milk, butter, cheese, and ice cream, as well as legally permitted substitutes; tests the products mentioned for conformity to legal definitions and sanitary standards; forbids the sale of, or destroys, materials which do not conform.

It inspects beef and dairy cattle, also horses, sheep, goats, swine, poultry, bees, and other domestic animals; diagnoses disease, establishes local quarantines, and suppresses epizootics. Of all diseases, the one receiving most attention over a range of years has been cattle tuberculosis. With federal cooperation, tuberculosis control areas (now including something like half the area of the State) are established; in these areas, all cattle are tested; all that react positively are slaughtered; and the owners are recompensed.

It licenses and inspects abbatoirs, and makes pre- and post-mortem inspections of slaughtered animals. The sale of meat without approval, which may be either federal, state, or municipal, is forbidden.

It registers brands and inspects hides and carcasses to prevent theft.

It licenses dealers in agricultural poisons, fertilizers, feeding stuffs, and seeds, and tests the goods sold for conformity to legal standards. The tests applied to seeds are for viability and for the presence of weeds.

It studies insects and the use of insecticides in the field; maintains quarantines and conducts campaigns of eradication against injurious insects.

It inspects hay, grain, and fresh fruits and vegetables. In some cases it merely certifies as to quality; in others it forbids the sale or shipment of inferior goods. In many cases it enforces the use of standard containers. At road inspection stations, citrus fruits are examined for frost injury; in laboratories, specimens of fruit from orchards are tested for spray residue. All plant material entering the state is inspected for the presence

of plants forbidden under quarantine regulations and for pests and diseases.

It watches out for diseases of cultivated plants and cooperates with the Federal Bureau of Entomology and Plant Quarantine in the enforcement of federal quarantines.

It conducts campaigns for the control of rodents, especially ground squirrels; and against noxious weeds. Camel thorn, an aggressive weed; the cultivated currant, a host of the white-pine blister rust; as well as all hosts of citrus white fly in citrus white fly districts, are, under the Code, public nuisances, subject to summary abatement. The Code includes a long list of other weeds which the Director is empowered to outlaw in limited areas within the state. In another place a definite list of species are legally defined as noxious weeds, with the requirment that their presence in agricultural seeds must be acknowledged on the label.

The department licenses and inspects nurseries. All nursery stock—defined as anything which is to be planted—must be inspected before shipment out of the county. Recent experiences had alarmed me with the notion that all plant material, including botanical specimens, must be inspected before shipment. As I read the law, it is not so unreasonable. Inspection is required, of all material to be planted; of all material from quarantined areas; and of material which is suspected for some other specific reason. Whether material to be shipped out of the state requires inspection depends upon Federal regulations and upon regulations at the destination.

The department licenses all warehouses and inspects them for the presence of insect pests. At the option of their proprietors, warehouses may be bonded; the department inspects bonded warehouses from the point of view of legality of business operations.

It licenses and oversees all dealers in agricultural products (with an exception in favor of cash buyers) to prevent any swindling of producers.

It gathers, in great detail, data as to volume of goods and prices in agricultural markets. The data assembled are made public at frequent intervals in mimeographed form or by radio.

It administers laws as to the manufacture and sale of mattresses and upholstered furniture and oversees the locally appointed sealers of weights and measures. The laws governing these last activities were deliberately not worked into the agricultural code; it seems probable that enforcement of these laws may eventually be assigned to some other agency of government.

The department prosecutes violators of the law, acting through local District Attorneys.

From this summary, it will be seen that the department is largely "self-supporting" by means of license fees.

Under the Code, County Boards of Supervisors are permitted to establish local agricultural administrations. The local officers are the County Agricultural Commissioner and the County Livestock Inspector, together with deputies as needed. Commissioners are appointed by Boards of Supervisors from among persons examined and approved by the Director. Their term is four years. Almost every county maintains a Commissioner. Livestock Inspectors require no qualifying examination, serve during the pleasure of the Board of Supervisors, and are permitted only a low maximum salary; in these facts one senses an expectation that the office may eventually be abolished and its functions transferred to the Commissioner.

The functions of the local agricultural officers are twofold: they are local agents of the Department, and are responsible to the Director; at the same time they are locally responsible for the enforcement of local regulations. The inspection of imported plant materials is carried out, at border stations, at airplane landings, at the important seaports of San Francisco, Los Angeles, and San Diego, and in the mail, freight, and express terminals in the same cities and in Oakland, by State Inspectors; at the less important ports of Eureka, San Luis Obispo, Santa Barbara, and Ventura, and at inland mail, freight, and express terminals in general, inspection is by Commissioners. Inspection required before shipping plant material is normally by Commissioners.

Before proceeding to an account of botanical investigation and publication by the department, a not unfriendly critic comments upon the organization as follows. This institution is on the one hand subject to damnation as a bureaucracy; on the other, it exemplifies the best modern theory of government. Responsibility is lodged in a high officer, an immediate deputy of the Governor, removable at pleasure; routine in a body of permanent professional public servants. The Board of Agriculture may be expected to serve, on behalf of the people and the agricultural community, the necessary function of criticism. One ventures the suggestion that the Board is not by law sufficiently independent of the Governor. Each Governor, when he has served slightly more than half of his term, has appointed a majority of the Board; and when he goes out of office he leaves a Board appointed entirely by himself. From a Board so constituted one expects no searching criticism of the Governor's other creature, the Director. This suggestion is not based on any specific happenings; the situation is the same as with many other boards belonging to the State Government, and cannot be said to cry aloud for reform. Similarly, in the use of locally appointed officers, the Commissioners, for the enforcement of State law, the Code follows good Californian precedent and practice rather

than abstract theory. It is the use of local officers that takes the curse of bureaucracy off the system.

Regarding research and the dissemination of information, the Department disclaims these as primary functions. They are primary functions of the University. Nevertheless, the routine work of the laboratories of the department yields data worthy of publication; and in emergencies, or when cooperation is altogether acceptable, research projects may be undertaken. There are several laboratories in the Department: a bacteriological laboratory, concerned largely with dairy products; a chemical laboratory for the analysis of insecticides, fertilizers, etc.; a laboratory and taxonomic collection for entomology; a mycological laboratory; and a seed laboratory. In connection with weed control, a herbarium has been started and plants are identified.

A periodical, the Monthly Bulletin,[3] now (1934) in its twenty-third volume, is published. In defiance of the title, it has been appearing during these years of financial stringency in batches of two or more numbers, at irregular intervals. Scientific papers, as well as a variety of matter of departmental interest, appear in it.

Among strictly technical papers, a large proportion deal with entomological taxonomy. Many others discuss diseases of cultivated plants; others discuss insects on native plants, and methods of control. Mackie and Jones[4] refer to the fact that European elm leaf beetle, a pest that threatens all our elms with destruction, and the obnoxious European elm scale, can be controlled by sprays applied with especially powerful pumps capable of elevating streams to the tops of the trees. The primary object of the paper cited is to report experiments carried out under normal operating conditions, which established the reassuring conclusion that the hazard of contact with power lines is negligible. More recently, Mackie and Haenggi[5] have described methods by which control is achieved at a cost of only eleven cents per tree: this was accomplished in Sacramento, where large-scale operations are possible. In communities that cannot afford the overhead expenses there remains serious danger of the loss of all elm trees. Burke[6] has presented a useful outline of the insects which may be expected on ornamental trees in gen-

[3] Before 1919, Monthly Bulletin of the State Commission of Horticulture; now Monthly Bulletin of the Department of Agriculture, State of California. This title would be cited as Monthly Bull. Dept. Agr. Calif., and is obnoxiously long; one remembers that Dr. Merrill suppressed Tech. Papers Agr. Exp. Sta. Univ. Calif., and replaced it with Hilgardia.

[4] Mackie, D. B., and M. L. Jones. An attempt to measure the hazard from power lines during spraying operations. Op. cit. 21: 196–203. 1932.

[5] Mackie, D. B., and Charles Haenggi. Recent developments in elm leaf beetle control. Op. cit. 22: 346–350. 1933.

[6] Burke, H. E. Summary of shade-tree insect activities in California for 1931. Op. cit. 21: 358–369. 1932.

eral. A paper by Salman[7] includes an account of the unhappy ravages of the pine killing beetles of the genus *Dendroctonus.*

Articles on diseases of plants, in contrast to those on insect damage, are less numerous. Millbrath[8] has written a brief summary of the situation. Root[9] has described the measures being taken against the introduction and spread of white pine blister rust. The measure most relied upon, the eradication of the alternate host wherever necessary, is impressive when one considers the abundance of gooseberries and currants in our mountains. The cultivated black currant is said already to have been eradicated throughout the western states. Harris and Goss[10] have described a disease of seedlings of species of *Andropogon,* in which the roots of the primary system and the mesocotyls turn red, wither, and die; the whole seedling dies unless the secondary system of roots is already well established. The disease appears sporadically, effecting small percentages of batches of seedlings; it seems not to be infectious, and no etiological agent was discovered. The authors conclude that it represents a physiological deficiency of some individuals. Weldon[11] has studied the delayed foliation of fruit trees. This condition, which appears in Southern California rather than Northern, and only in certain years, seems to be a response to the environment: when winters are unusually mild, trees from a harsher climate lack the stimulus to unfold their buds. Harris[12] has an article on cold injury. It was prepared and published before the great freeze of December, 1932, when oranges, eucalyptus, pepper trees, *Grevillea, Phoenix canariensis* Hort., some species of *Acacia,* and other natives of warm climates, suffered extreme damage. To the surprise of most people who witnessed the results of the freeze, many trees which were not promptly removed managed to go on living. A detailed account, by species, of the damage, would be most interesting.

In the field of economic mycology aside from plant pathology, Millbrath[13] has an article on wood decay, as caused particularly

A detailed account of the most troublesome weeds of Cali-

by *Poria incrassata* and *Merulius lachrymans.*

[7] Salman, K. A. Forest insects of the year 1932. Op. cit. 22: 131–137. 1933.

[8] Millbrath, D. G. Plant diseases in California. Op. cit. 23: 197–200. 1934.

[9] Root, G. A. Progress of preparedness for protecting sugar pine against blister rust. Op. cit. 21: 204–210. 1932.

[10] Harris, M. R., and W. L. Goss. A seedling disease of sorghum and sudan grass. Op. cit. 23: 109–118. 1934.

[11] Weldon, G. P. Fifteen years study of delayed foliation of deciduous fruit trees in Southern California. Op. cit. 23: 160–181. 1934.

[12] Harris, M. R. Some examples of cold injury to plants in California during the winter of 1931–32. Op. cit. 21: 354–357. 1932.

[13] Millbrath, D. G. Wood decay in buildings. Op. cit. 23: 95–102. 1934.

fornia is appearing as a series of articles by Ball and Robbins,[14] with beautiful colored plates by Lena Scott Harris. The whole of one number of Volume 22 is devoted to weeds. In addition to contributions of the Ball and Robbins series, we find discussions of weed control by Ball, Bottel, Crafts, Goodwin, Ryan, and Wren. The campaign against camel thorn seems to be yielding results and to promise complete success. In the same number are papers on the artichoke thistle; on the relation of weeds to diseases and insect pests; on the occurrence of weed seed in crop seed; on *Lepidium Draba* L., and on *L. repens* Bois. and *Hymenophysa pubescens* C. A. Mey., weeds confused with it; an account of the star thistles, genus *Centaurea,* which should be most useful in the indentification of collections; and an announcement of an experiment on the viability of weed seeds. This experiment is planned to be continued over a period of thirty-six years.[15] At various times Bellue[16] has written other articles on weeds; noting the appearance of *Roripa austriaca* Spach and *Carduus neglectus* Ten., and (with Ball)[17] discussing *Cyperus esculentus* L.

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[14] Ball, W. S., and W. W. Robbins. Russian knapweed (*Centaurea repens* L.) Op. cit. 20: 666–668. 1931.—Puncture vine (*Tribulus terrestris* L.) Op. cit. 21: 211–213. 1932.—Johnson grass (*Holcus halepensis* L.) Op. cit. 21: 287–289. 1932.—Bermuda grass (*Cynodon dactylon* Pers.) Op. cit. 21: 322–323. 1932.—White horse nettle (*Solanum elaeagnifolium* Cav.) Op. cit. 21: 348–349. 1932.—Canada thistle (*Cirsium arvense* Scop.) Op. cit. 21: 394–395. 1932.—Quack grass (*Agropyron repens* Beauv.) Op. cit. 21: 414–415. 1932.—Camel thorn (*Alhagi camelorum* Fisch.) Op. cit. 22: 258–259. 1933.—Spiny clotbur (*Xanthium spinosum* L.) Op. cit. 22: 278. 1933.—Perennial sow thistle (*Sonchus arvensis* L.) Op. cit. 22: 286. 1933.—Poverty weed (*Iva axillaris* Pursh) Op. cit. 22: 305. 1933.—Sandbur (*Cenchrus pauciflora* Benth.) Op. cit. 22: 318. 1933.—Heliotrope (*Heliotropium curassavicum* L.) Op. cit. 22: 379–380. 1933.—Klamath weed (*Hypericum perforatum* L.) Op. cit. 23: 103–108. 1934.

[15] Ball, W. S. Weed control. Op. cit. 22: 252–257. 1933. Bottel, A. E. Introduction and control of camel thorn. Op. cit. 260–263. Crafts, A. S. Progress in chemical weed control. Op. cit. 264–268. Ball, W. S. Artichoke thistle (*Cynara cardunculus* L.) Op. cit. 269. Wren, C. H. Report on genesis and present status of the artichoke thistle problem in Solano County. Op. cit. 269–272. Harris, M. R., and G. L. Stout. Weeds as a factor in the spread of plant diseases in California. Op. cit. 273–277. Lockwood, S. The relation of weeds to insect pests. Op. cit. 279–282. Bunting, Leatha. Noxious weed seeds found in crop seeds. Op. cit. 283–285. Bellue, Margaret K., and W. S. Ball. Hoary cress (*Lepidium Draba* L.) Op. cit. 287. Bellue, Margaret K. New weeds confused with hoary cress. Op. cit. 288–293. Ball, W. S., W. W. Robbins, and Margaret K. Bellue. The star thistles (*Centaurea* spp.) Op. cit. 294–298. Goodwin, P. M. Weed control by means of soil sterilization. Op. cit. 299–301. Goss, W. L. Buried seed experiment. Op. cit. 302–304. Ryan, H. J. Progress of pest eradication in California. Op. cit. 306–313.

[16] Bellue, Margaret K. Austrian field cress—new and noxious. Op. cit. 22: 385–386. 1933.—*Carduus neglectus* Ten. Italian thistle. Op. cit. 23: 195. 1934.

[17] Ball, W. S., and Margaret K. Bellue. Nut grasses. Op. cit. 23: 182–184. 1934.

and *C. rotundus* L., the species of this genus which are most troublesome as weeds.

Her article[18] on the weeds whose seeds are found in seed rice came to my attention ten years after my experience in rice growing ended; the following comments are offered with diffidence. The distribution of weeds in seed rice does not perfectly reflect their distribution in the field. Common cat-tail is among the most serious of rice-field weeds; its seeds are found, however, in only 6% of the samples tested, and, when present, they are not exceedingly numerous. This is to be expected from the fact that cat-tail is disseminated by wind. Aside from cat-tail, the weeds formerly most dreaded were water grass (*Echinochloa;* several races which the best authorities refuse to name except as *E. Crus-galli* Beauv.) and wire grass (*Eleocharis palustris* R. Br.). Of these *Echinochloa* is duly reported as found in 81% of the samples and represented by more seeds per pound than any other weed except *Ammania; Eleocharis* is represented in only 4% of the samples, and by but few seeds. *Alisma Plantago-aquatica* L., *Echinodorus cordifolius* Griseb., and *Ammania coccinea* Rottb. may not be as troublesome in the field as the abundance of their seed would suggest. By law, all species of *Cyperus* seem to be "noxious weeds." *Cyperus esculentus* L. and *C. rotundus* L., the species which seem to have won the genus its reputation, are not among the species common in rice fields. The three common species of rice fields have been determined respectively, as *C. virens* Michx. (otherwise *C. vegetus* Willd.; *C. serrulatus* S. Wats.), a perennial, abundant only on dikes; *C. diandrus* Torr. (or *C. melanostachys* H. B. K.), an annual sometimes abundant in the shade of the rice; and *C. erythrorhizos* Muhl., an annual, growing taller than the rice in the open paddy. Of these, only the last is apparently likely to make trouble; and it has not proved troublesome in practice. The same may be said of *Leptochloa fascicularis* (Lam.) Gray. A few occurrences of *Centaurea solstitialis* L. and *Holcus halepensis* L.—legally noxious weeds—are reported. These will do the rice grower no harm. In general, the lists of weeds reported in less than 5% of the samples are of plants common everywhere, nowhere troublesome in cultivated fields, and least troublesome of all in rice. An undetermined species of *Scirpus* is said to have become abundant since 1926. This report seems ominous. Earlier freedom from *Scirpus* may have depended on dissemination less efficient than that of *Typha*. A growing abundance of red rice is also ominous. Redness in rice is not to be considered the mark of one race; it is a genetic character which can be combined with many others. The essential objection to it is aes-

[18] Bellue, Margaret K. Weeds of California seed rice. Op. cit. 21: 290–296. 1932.

thetic; customers do not want it. There is also apparently some tendency for red races to tiller poorly, to produce small heads, and to shatter; in short, to be poor yielders. I suspect a tendency to fruit early; this may explain the absence of red rice in the old *wataribuni* and its presence in the subsequently developed earlier varieties. Eradication will not be easy. It is not always possible to recognize and pull by hand individual plants which will produce red seed; and manipulation of water level, by which many weeds can be placed at a disadvantage, cannot be expected to damage one race of rice more than another.

All this work on weeds may lead to the publication of a new weed book for California. The old one, Smiley's useful work,[19] was published as a number of this same Monthly Bulletin. This review of botanical papers in recent volumes of the Monthly Bulletin would be incomplete without reference to the report of Goss and Bunting[20] on the viability of flower seeds.

In addition to the Monthly Bulletin, the Department issues a numbered series of special publications. Subjects of temporary or limited interest are handled in this series, of which the latest (as of November, 1934; No. 129) is a directory of nurserymen and florists in California. Formerly, when the Board of Agriculture had administrative responsibilities, it issued an annual statistical report on the agriculture of the State. The last of this series, a volume of more than five hundred pages of text, appeared in 1921. It was a most useful work of reference, including material for which one must now search in many places; but preparation was expensive and perhaps not justified by the demand.

In the preparation of this account, I have had the assistance of members of the Department, and especially of Mr. W. C. Jacobsen, Administrative Assistant and Supervisor of Rodent and Weed Control. It is a pleasure to express cordial appreciation of this assistance. The facts stated, however, are based on my own reading, and the opinions are my own: the responsibility is entirely mine.

Sacramento Junior College,
December, 1934.

A FOSSIL HAZELNUT

HERBERT L. MASON

The genus *Corylus* is not known to occur south of the Santa Cruz Mountains in California. This distribution appears somewhat anomalous since most of its associates occur in the Santa

[19] Smiley, F. J. Weeds of California and methods of control. Op. cit. 11: i–xxii, 73–360, figs. 15–138. 1922.

[20] Goss, W. L., and Leatha Bunting. Progress report on length of time flower seeds retain their viability under favorable storage conditions. Op. cit. 22: 413–415. 1932.

Lucia Mountains an additional one hundred miles southward. Yet *Corylus* has not been reported from these mountains. In the Pleistocene floras[1] of Southern California on Santa Cruz Island and at Carpinteria, Chaney and Mason did not report it. In the Tomales flora of Central California it was very abundant. It is of interest to place on record the finding of a fossil nut of *Corylus* by J. F. Katenkamp in a gravel pit in the hills overlooking Montecito in Santa Barbara County. The position of the nut in these gravels as well as the position of the gravels in the geological sequence is in some doubt. An excerpt from a letter by Mr. David B. Rogers of the Santa Barbara Museum of Natural History indicates the status of our information as to the origin of the specimen. "The pit from which it came is at least one thousand feet above sea level, standing at least 70 degrees to the horizontal. It is a reformed deposit of older material quite compact, and giving the appearance of considerable age. However, it *may* be no earlier than early Pleistocene. It is fairly uniform in texture throughout a considerable depth, only the upper few feet differing, this stratum being considerably less in density, and is unconformable with the more compact strata beneath. The fruit might easily have originated in this upper, more recent formation, and have trickled down into the older material in the course of quarry operations."

The nut is flattened on four faces due to pressure and its tissues are carbonized. Due to the absence of any other parts of the plant and to the uncertainties of its age no specific name is assigned to it. The material is deposited in the Santa Barbara Museum of Natural History as *"Pal. Bot. 1 '33."*

University of California

STUDIES IN WESTERN VIOLETS—I

Milo S. Baker

Sections Chamaemelanium and Nomimium

All of the western forms of *Viola,* except two, fall without dispute, into two groups known as sections *Chamaemelanium* and *Nomimium.* Although this paper deals only with section *Chamaemelanium,* it is impossible to use the key effectively until one can distinguish the two sections one from the other. In the first place each of our western violets can be assigned easily to its proper section by knowing either the coloring of the corolla or the nature of its habitat. For example, all of the yellow flowered species belong to section *Chamaemelanium.* This section also includes all forms with any yellow color whatever in the corolla. For instance, *Viola Beckwithii* T. & G., *V. trinervata* Howell, *V. Flettii* Piper do not appear to be yellow at all, but a close inspection will disclose that the bases of the petals as well as the spur are yellow or yellowish. Then we have three *Cha-*

[1] Chaney, Mason, Potbury. Carnegie Inst. of Wash. Pub. No. 415. 1934.

maemelanium violets that are nearly white, namely, *V. ocellata* T. & G., *V. rugulosa* Greene and *V. canadensis* L., but again the spur and the bases of the petals are distinctly yellow. Although the color character in many groups of plants is often a poor diagnostic character, in *Viola* this yellow corolla color is invariably associated in the western species, with a flower structure which is nearly identical in all of the *Chamaemelanium* species. This will be explained more fully presently.

Considering next their habitats, all but two of the *Chamaemelanium* species are dry-land plants, that is, they are adapted to the rainless summers of the western states and thrive during the season of rainfall and until the moisture dries beyond the reach of their roots, when they die down to their perennial rootstocks and begin their summer sleep, finally to awaken with a new season of moisture and warmth. Indeed several of our species do not wait for a marked increase in temperature, but begin growing soon after the first fall rains. This is true of two of our finest wild pansies, *V. Douglasii* Steud. and *V. pedunculata* T. & G., whose leaves may be found coming through the ground in December and even in the latter part of November in years of early rains.

The only two *Chamaemelanium* violets that prefer places moist throughout the year are *V. glabella* Nutt. and *V. biflora* L. both of which are found in well drained moist situations. Attention should be called to the fact that most authorities assign the latter species not to section *Chamaemelanium* but to section *Dischidium*. However, in the proper place in a subsequent paper, I shall contend that this species should be assigned to section *Chamaemelanium*.

We come now to a consideration of the flower structure of a *Chamaemelanium* violet. In plate II, figure 1, is shown a median vertical section of the flower of *V. Nuttallii* Pursh subsp. *praemorsa* (Dougl.) Piper. The lower petal and its spur as well as the ovary and two of the stamens are shown. The end of the style and stigma may be seen pressed closely against the floor of the lower petal. Indeed the head of the style and the lower lip of the minute stigmatic tube fit so exactly into the groove of the lower petal that such a small insect as thrips is unable to force an entrance underneath or on either side and must perforce crawl over the head to continue on its way to the nectary of the spur (pl. II, fig. 1). The bearding of the head (pl. II, fig. 4) appears to assist in blocking direct passage to the nectary.

The anthers in *Viola* have a peculiar structure (pl. II, fig. 2). The filament is extremely short, and the anther connective is developed anteriorly into a membranous appendage (pl. II, fig. 2, *a*). Further, the five anthers which surround the pistil are closely fitted together with the pollen sacs opening inward. The anterior appendages overlap at each joint and becoming lightly joined together make a pollen-tight sheath, through the distal

end of which projects the head of the style (pl. II, fig. 3). In section *Chamaemelanium* this stamen-sheath fits tightly about the style at every point except for a minute pore formed by the turning back of the flaps of the anterior appendages of the ventral stamens at their point of junction, thus forming the *collar opening* (pl. II, fig. 3, *h*). This opening allows the pollen, as it is discharged from the pollen sacs into the interior of the stamen-sheath, to sift downward into the *pollen trough* of the lower petal at a point immediately behind the head of the style.

The utility of this flower structure in advancing pollination is easily shown. On many occasions I have watched a thrips crawl along the groove of the lower petal till stopped by the close fitting head of the style. This insect then examines the blocking obstacle with its antennae seeking a passage around it. In this prospecting, the stigma is almost certain to be pollinated by some of the grains to be seen adhering abundantly to the surfaces of the antennae. At length this minute insect crawls over the head of the style and drops down into the pollen trough beneath the collar opening and thus gets covered with new pollen.

This brings us to a consideration of the nectary shown at *b* (pl. II, fig. 2). This consists of two outgrowths from the connectives of the two ventral anthers. These outgrowths or *posterior appendages* of the ventral stamens extend downward and backwards into the spur cavity and secrete minute drops of nectar. These hang downward side by side, in contact in some species and in others separated by a small space. These nectaries are shown again in plate II, figure 3 at *l*.

Turning now to section *Nomimium* of the violets, it is to be noted that the western species in this group may also be identified by the color of the corolla and by the nature of the habitat. The corollas may be either white, blue, or purple. All white violets (without *any* yellow) growing in the west, except *Viola Rafinesquii* Greene belong to the section *Nomimium*. All blue violets likewise and all wholly purple flowered species are members of the *Nomimium* group.

While the *Chamaemelanium* violets are mainly dry-land plants, the *Nomimium* violets are mainly moist-land plants, there being but one western *Nomimium* violet that is found growing in spots that become dry when the rainy season has passed. This is *Viola Howellii* Gray which is mainly confined to a humid strip along the coast of Oregon and Washington.

The *Nomimium* flower structure is different in several particulars from that typical of *Chamaemelanium* violets. Here the stigma is held somewhat above the floor of the lower petal (pl. II, fig. 7) and is thus adapted to pollination by larger insects such as flies and bees. The spur is longer and the style head and stigmatic tube are of a different shape and the style bearding, when present, is shorter and differently distributed. Also the

bearding of the lateral petals is much longer and the hairs less clavate. There is no collar opening in the stamen-sheath, the pollen sifting between the loosely overlapping edges of the anterior appendages. Another difference is the longer nectaries correlated of course with the longer spurs. Thus the flower structure of our western violets offers an unfailing guide by which these two sections of *Viola* may be distinguished.

The presence in Colorado of a single violet species belonging to section *Melanium* of *Viola* deserves some attention. In Europe representatives of this section are very numerous, but *Viola Rafinesquii* Greene is the only *Melanium* violet that is native to North America. Nevertheless this section is more widely known than section *Chamaemelanium* or possibly even than section *Nomimium* because of the introduction to America of the *Melanium* pansies of Europe. In flower structure the *Melanium* violets are more closely related to section *Chamaemelanium* than to section *Nomimium*. This close relationship is indicated by naming them dwarf *Melanium* violets (Chamae, signifying dwarf). As in section *Chamaemelanium* the style head fits closely into the groove of the lower petal, and the stamen-sheath possesses a collar opening although less clearly defined. But the style head is more massive, and has no beards, nor the delicate stigmatic tube. Instead the stigmatic surface is an internal cavity of the style head, opening to the outside by a large stigmatic orifice. However, the most conspicuous character of the *Melanium* violets is the large foliaceous stipules. These are sometimes as long and even as large as the leaf itself.

In Part II we hope to consider the group *Nuttallianae* Becker.

Key to the Species of Section Chamaemelanium

Access to the spur cavity blocked by the much expanded, retrorsely bearded, gibbous head of style, which fits closely into groove of lower petal; stamen-sheath open at collar; stigma a mere lip or barely tubular; corolla yellow throughout, or yellow and purple, or purple and lilac, but always with a touch of yellow at least on the spur; bearding of lateral petals short and clavate; spur about as broad as long.

1. Leaves dissected, apparently subcaulescent because of the deep seated rootstock.
    2. Plants of open grassy places; rootstock short and vertical; leaves twice to thrice pinnatifid; flowers yellow or of two contrasting colors, pansy-like.
        3. Aerial stems quite evident; foliage not succulent; at least lower petal yellow.
            4. Minutely pubescent; flowers bright yellow .... 10. *V. Douglasii*
            4. Glabrous; upper petals dark livid purple, lower cream .... 11. *V. Hallii*
        3. Aerial stems less evident; foliage somewhat succulent; upper petals madder-violet, lower lilac.
            4. Minutely pubescent; leaf segments not becoming coriaceous .... 12. *V. Beckwithii*

4. Glandular; leaf segments 3-ribbed and becoming coriaceous .... 13. *V. trinervata*
2. Plants of wooded or brushy slopes; rootstock elongate, ascending; leaves twice palmatifid; flowers yellow, not pansy-like .... 7. *V. Sheltonii*
1. Leaves undivided (sometimes lobed in *V. lobata.*)
2. Corolla yellow on face except for dark veining.
3. Plants strictly erect with leaves and flowers crowded at ends of stems, these naked below; basal leaves large, thin, cordate, acute; capsule glabrous, acute.
4. Pubescent to puberulent; upper petals backed with brown; stipules somewhat foliaceous, toothed; leaves entire or lobed .... 8. *V. lobata*
4. Mostly glabrous; upper petals not backed with brown; stipules more or less scarious, entire .... 9. *V. glabella*
3. Plants erect, ascending, or prostrate; leaves and flowers scattered along stems; leaves various; capsule pubescent or glabrous, obtuse.
4. Stems prostrate or ascending; leaves orbicular or nearly so, puberulent.
5. Stems long, prostrate, rooting; leaves coriaceous, evergreen, mostly with an apical point. Transition Zone 5. *V. sempervirens* subsp. *typica*
5. Stems weak, ascending; foliage annual or evergreen. Above Transition Zone.
6. Basal leaves evergreen, mostly without apical point; stems short, ascending, 1–2 nodes with undeveloped leaves. Canadian Zone.. 5a. *V. sempervirens* subsp. *orbiculata*
6. Leaves thin, annual, orbicular to reniform; stems of 1–3 nodes with fully developed leaves. Boreal Zone .... 6. *V. biflora*
4. Stems erect or ascending; at least upper leaves narrowed.
5. Rootstock more or less elongate; flowers 2 cm. or less across; herbage pubescent.
6. Capsules glabrous or glabrate; leaves thin, erect, elongate, elliptic to ovate; pubescence variable but longer than in *V. purpurea*, at least leaf margins ciliate; upper petals usually yellow on back .... 3. *V. Nuttallii*
6. Capsules appressed puberulent; earliest leaves purplish beneath, orbicular to ovate, irregularly dentate, thicker, less elongate and erect than in *V. Nuttallii;* at least two upper petals brown backed.
7. Later leaves elongate, obtuse, but not linear or canescent (except in subspecies) .... 1. *V. purpurea*

7. Later leaves linear-lanceolate, acute, canescent; flowers smaller than in *V. purpurea;* all petals brown backed .... 2. *V. pinetorum*
5. Rootstock short and thick, deep seated; flowers more than 2 cm. across; capsules glabrous .... 4. *V. pedunculata*
2. Corolla white to purple; upper petals reddish violet on back; seeds without caruncle; erect plants; woodlands (except *V. Flettii*).
3. Plants pubescent; leaves rugose.
4. Corolla white with a purple spot near base of lateral petals .... 14. *V. ocellata*
4. Corolla white on face except for veining.
5. With underground stolons; some leaves wider than long, more pubescent below than above, margins coarsely serrate, ciliate.. 15. *V. rugulosa*
5. Without underground stolons; leaves as long or longer than wide, more pubescent above than below, margins finely serrate, glabrous.
6. Stems 15–35 cm. high; puberulent 16. *V. canadensis*
6. Stems 10–15 cm. high; glabrate.. 17. *V. scopulorum*
3. Plants glabrous; leaf surface not rugose.
4. Corolla white, veined and blotched with purple; leaf blades mainly vertical, cuneate .... 18. *V. cuneata*
4. Corolla reddish violet, except for yellowish spur; leaves cordate to reniform.... 19. *V. Flettii*

Santa Rosa Junior College,
Santa Rosa, California,
January 15, 1935.

Explanation of the Figures. Plate II

Section Chamaemelanium

Fig. 1. Median vertical section of flower of *Viola Nuttallii* subsp. *praemorsa* × 3.

Fig. 2. Side view and cross section of stamen of *Viola Nuttallii* subsp. *praemorsa* × 10: *a*, anterior appendage; *b*, nectary; *c*, filament; *d*, pollen sac.

Fig. 3. Stamen-sheath and head of style of *Viola sempervirens* subsp. *typica* × 10: *f*, head of style; *e*, stigmatic tube; *g*, bearding of head; *i*, anterior appendages of two ventral stamens; *k*, anther proper; *l*, spur appendages or nectaries; *m*, filament; *n*, receptacle.

Fig. 4. Dorsal view of pistil of *Viola Nuttallii* subsp. *praemorsa* × 10: *a*, head of style; *b*, bearding; *c*, style; *d*, ovary.

Fig. 5. End view of head of style *Viola Nuttallii* subsp. *praemorsa* × 10: *a*, stigmatic tube.

Fig. 6. Side view of *Viola Nuttallii* subsp. *praemorsa* × 10: *a*, stigmatic tube.

Section Nomimium

Fig. 7. Median vertical section of flower of *Viola adunca* × 3: *a*, *d*, anterior appendage of stamen; *b*, head of style; *c*, stigmatic tube; *e*, pollen sac; *f*, ovary; *g*, spur apendage; *h*, bearding of lateral petal.

Fig. 8. Side view of ventral stamen of *Viola adunca* × 10: *a*, anterior appendage; *b*, pollen sac; *c*, filament; *d*, spur appendage.

Fig. 9. Side and end views of style of *Viola adunca* ×10: *a*, stigmatic tube; *b*, bearding.

Fig. 10. Dorsal stamen of *Viola adunca* viewed from ovary × 10: *a*, anterior appendage; *b*, pollen sac; *c*, filament.

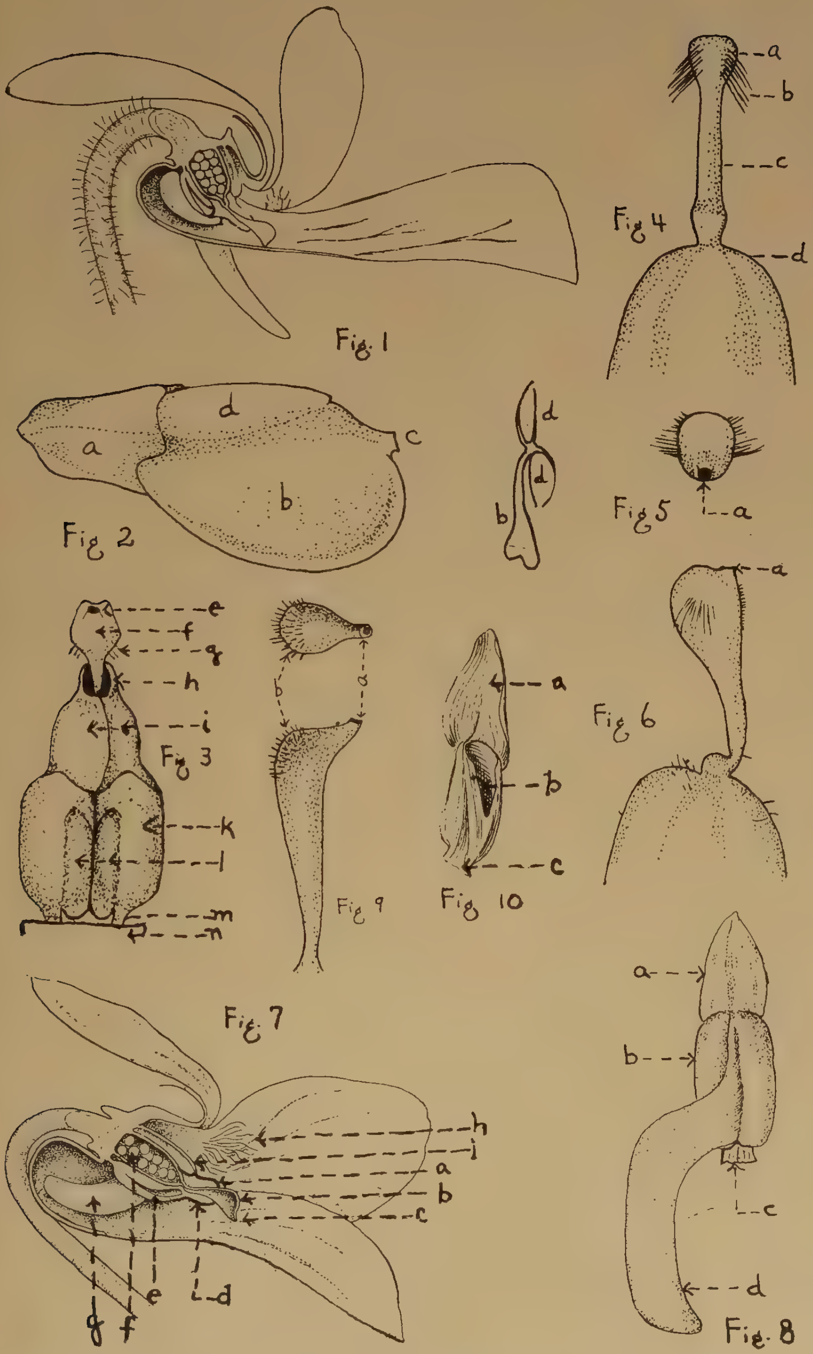

PLATE II. VIOLA: SECTIONS CHAMAEMELANIUM AND NOMIMIUM.

THE GENUS ERYTHRONIUM: A TAXONOMIC AND DISTRIBUTIONAL STUDY OF THE WESTERN NORTH AMERICAN SPECIES

Elmer Ivan Applegate

It seems likely that the ancestral home of the genus *Erythronium* was far to the north. Through southerly migration we now find the species widely spread, quite encircling the land area of the north temperate zone. Not only have they thus become separated, but they are now more or less completely isolated between sea, mountain, and desert barriers. Whatever their progenitors were like, and however they reached their present habitats, they have accommodated themselves to the varying conditions along the way, and for a long time have been adapting themselves to their present environment. The Old World species, although most widely dispersed east and west, appear to be much alike, and on the whole apparently more closely allied to the eastern North American species than to our western forms. The western North American species, although having the most restricted lateral distribution, are by far the greatest in number, and show the most divergent range of differentiation. Of the Eurasian group, only three or four species have been generally recognized. The genus extends westward from Japan through Formosa, northern Mongolia, southern Siberia and Russia, and central Europe to the Pyrenees Mountains. In North America the species are divided by the Rocky Mountains into two well defined groups. East of this range they are widely distributed throughout the United States and southern Canada, some five species being listed. From the Rocky Mountain region westward to the Pacific, I am including fifteen species and three subspecies or varieties. Thus there seem to be at least two dozen known species in the world, as against from a dozen to fifteen heretofore listed. With the extension of more systematic work, probably other species will be added. Within the *Erythronium* range of central Asia are vast unexplored regions where it is likely that in the future new species will be found. If the western situation as I found it is any criterion, some revision may be found necessary not only in eastern North America, but possibly in Europe.

The present paper deals with the western North American species embraced within the region of the Rocky Mountains and westward to the Pacific Ocean. It is based upon a detailed and critical field study covering practically the entire range of all of the known forms, and extending over a period of a dozen years. The specific areas investigated include southwestern Alberta, southern British Columbia, Washington, Oregon, California, Idaho, Montana, Colorado and Utah. *Erythronium* has not been found in Nevada, Arizona and New Mexico. While nearly all of the forms had been collected, so imperfectly were

they known, that a number of new ones had long been erroneously referred to published species, the feeling among botanists in general being that no new species were likely to be found. Heretofore no attempt has been made to work out the various forms in the field. Not since 1891, the date of Watson's[1] revision, has any kind of comprehensive treatment of the North American species been published. Dr. Watson had little field knowledge of the western species. His descriptions for the most part were based upon herbarium material and incomplete notes of local collectors. With such inadequate material, he himself expressed hesitancy in proposing his revision.

My interest in *Erythronium* dates back to my boyhood home in the Siskiyou Mountain region of southwestern Oregon. This is the very center of the *Erythronium* world. Over one third of the known species are concentrated within the limits of the old cretaceous "Siskiyou Island" of southwestern Oregon and northwestern California. This is a region of many interesting endemics, and the meeting place of plants from widely separated sections. Here, while a student of botany at Stanford University, my first *Erythronium* collections for scientific purposes were made in 1895. Other collections were made in the same region and in the Cascade Mountains of Oregon during the seasons of 1897–'98, at which time I was acting as assistant to Dr. Coville, botanist of the U. S. Bureau of Plant Industry. It had become increasingly evident that the only way to know these interesting plants was to visit them in their native haunts. Not until many years later was I in a position to take up the work in earnest. The initial investigation was undertaken in the Siskiyou Mountains and southern Cascades of Oregon in 1921, and concluded in the Rocky Mountains in 1933. All descriptions were drawn in the field from the living plants. The geographic distribution has been worked out from my own extensive travels, and from the examination of a large number of collections, from those of the earliest botanical explorers on. The trails of most of these have been followed throughout the west. Nearly all of the types have been examined, and most of the type localities have been visited. The western universities and other schools and institutions having plant collections were also visited, where all *Erythronium* material was examined and botanists consulted concerning them. The work of preparing the manuscript for publication was done at the Dudley Herbarium of Stanford University.

The pursuit of these elusive and strikingly beautiful plants furnished a rare opportunity for the indulgence of an innate liking for wilderness wandering. In nearly all of these delightful ramblings, my wife was my constant and helpful companion.

In the examination of specimens, I have had the use of the

[1] Watson, Sereno. A Revision of the American Species of *Erythronium*. Proc. Am. Acad. 26: 125–130. 1891.

collections from the following herbaria, each designated in citations by initials:

Dudley Herbarium of Stanford University, California (DH)
University of California, Berkeley (UC)
California Academy of Sciences, San Francisco (CA)
University of Oregon, Eugene (UO)
Oregon State College, Corvallis (OS)
Willamette University, Salem, Oregon (WU)
University of Washington, Seattle (UW)
Washington State College, Pullman (WS)
University of Idaho, Moscow (UI)
University of Montana, Missoula (UM)
Montana State College, Bozeman (MS)
University of Wyoming, Laramie (UWy)
University of Colorado, Boulder (UCo)
Colorado State College, Ft. Collins (CS)
University of Utah, Salt Lake City (UU)
University of British Columbia, Vancouver (BC)
Provincial Museum, Victoria, Vancouver Island (PM)
(All of the foregoing were visited).
Gray Herbarium, Cambridge, Mass. (GH)
National Herbarium, Washington, D. C. (US)
Philadelphia Academy of Sciences, Philadelphia, Pa. (PhA)
New York Botanical Garden, New York City (NY)

I take this opportunity to thank those in charge of the herbaria named above, as well as many others, both here and abroad, who have assisted me in this work; and I wish especially to express my appreciation to Dr. L. R. Abrams, Professor of Botany at Stanford University, for much helpful advice and encouragement.

Key to the Western Species of Erythronium

Leaves not mottled, bright yellow-green; flowers white, creamy-white, or golden-yellow. Essentially of the high mountains (Canadian and Hudsonian zones), but descending into the yellow pine regions (Transition Zone) east of the Cascade Mountains .... Section Concolorae
  Stigma entire or nearly so.
    Style short, strongly clavate; flowers white or creamy-white.
      Perianth segments without appendages, narrow. Sierra Nevada and Cascade Mountains of California .... 1. *E. purpurascens*
      Perianth segments with appendages, broader. Cascade Mountains of southern Oregon, and Siskiyou Mountains of northern California and southern Oregon .... 2. *E. klamathense*
    Style long, filiform; flowers golden-yellow.
      Perianth segments without appendages; anthers red. Sawtooth Mountains of Idaho .... 3. *E. nudopetalum*

Perianth segments with appendages; anthers golden-yellow; plants propagating by clump-forming offsets ..... 4. *E. tuolumnense*
Stigma definitely lobed, the lobes at length recurved; style long, usually not strongly clavate.
Flowers golden-yellow.
Anthers red. East side of the Cascade Mountains to the Rocky Mountain region .... 5. *E. grandiflorum*
Anthers white; filaments of irregularly unequal length in each set. Northern Rocky Mountain region westward to the coast ranges .... 5a. *E. grandiflorum* var. *pallidum*
Anthers golden-yellow; style often stouter and stigma lobes shorter. Central Rocky Mountain region and southward; locally in northern Idaho .. 5b. *E. grandiflorum* subsp. *chrysandrum*
Flowers white.
Anthers white; leaves usually oblanceolate. Along the border of Idaho and Washington .... 6. *E. idahoense*
Anthers golden-yellow; leaves lanceolate, commonly abruptly narrowed to a distinct petiole. High Cascade, Olympic, and British Columbia coast mountains .... 7. *E. montanum*
Leaves mottled, that is, the green to dark brown upper leaf surface divided into irregular areas by lighter colored lines; flowers white or creamy-white, pink or lavender, never golden-yellow; the colored segment bases usually broken by splotches or transverse bands. Essentially of the lowlands and foothills. Transition Zone .... Section PARDALINAE
Stigma entire or nearly so; style short and strongly clavate. Southwestern Oregon and northwestern California.
Flowers white or creamy-white.
Segments without appendages.......... 8. *E. Howellii*
Segments with appendages .... 9. *E. citrinum*
Flowers lavender, segment bases dark purple .... 10. *S. Hendersonii*
Stigma plainly lobed; style long and filiform; segments with appendages.
Filaments strongly dilated.
Flowers rose-pink. Near the coast from northern California to British Columbia .... 11. *E. revolutum*
Flowers white or creamy-white. West of the Cascade Mountains.
Anthers golden-yellow. Mostly from central Oregon northward to British Columbia .... 12. *E. oregonum*
Anthers white. From central Oregon southward to Rogue River .... 12a. *E. oregonum* subsp. *leucandrum*
Filaments filiform. California.
Stem branching above the leaves; stigma lobes stubby.

Anthers white. Sonoma and Lake counties northward to Humboldt and Trinity counties	13. *E. californicum*
Anthers golden-yellow; plants propagating by sessile offsets. Mt. St. Helena region, Napa, Lake, and Sonoma counties	14. *E. helenae*
Stem branching at the leaves; stigma lobes long and filiform; propagating by long underground runners. Foothills of Sacramento and San Joaquin valleys	15. *E. multiscapoideum*

1. Erythronium purpurascens S. Wats. Proc. Am. Acad. 12: 277. 1877. *Erythronium grandiflorum* var. *multiflorum* Torr. Pac. R. R. Rep. 4: 146. 1867. *Erythronium purpurascens* var. *uniflorum* S. Wats. Bot. Cal. 2: 171. 1880.

Corms commonly 3–4 cm. long, 5–6 mm. thick, sometimes retaining the remains of old ones for several years; leaves bright yellow-green, 10–15 cm. long, 1–2 cm. broad, usually lanceolate to linear-lanceolate, acuminate (the larger sometimes obtuse), rarely oblanceolate, narrowed to a short, narrowly winged petiole; scape frequently slender and weak, sometimes more or less flexuous or tortuous, 5–20 cm. high, or higher; flowers small and delicate, often several to many on short slender pedicels, sometimes the uppermost longer, perianth segments usually linear-lanceolate, 10–15 mm. long, 2–4 mm. broad, bluntish, white with plain pale yellow base, those of the inner set entirely naked; filaments filiform, short (4–5 mm.); anthers white, at least twice the length of the filaments before dehiscence; style yellow, short, 4–5 mm. long, clavate; stigma very shortly to obscurely lobed or notched; capsule oblong-obovoid, blunt, 2–3 cm. long, 7–8 mm. thick.

This is the smallest and most delicate flowered of our western species. It flowers immediately after the disappearance of the snow, following the retreating drifts. The tendency of the perianth segments to turn pinkish or purplish with age or in drying is unusually marked.

Distribution: Canadian and upper Transition zones, in meadows, along streams in openings in coniferous woods. Usually found in rather small colonies, these often widely separated, especially southward. Southern Cascade Mountains from Mt. Lassen southward through the high Sierra Nevada to Mt. Moses, Tulare County, California. More common throughout the greater part of the upper drainage area of Feather River, which covers most of Plumas County, in well watered volcanic soil of good depth; increasingly rare southward in the older, glaciated and more precipitous high Sierra Nevada, where soil and moisture conditions are less favorable. Separated from *E. klamathense* Applegate, its nearest ally, by the Pit River and Klamath River gaps on the north, and from the Siskiyou region to the westward by the valley of the upper Sacramento River.

Apparently never intimately associated with either of the other two species of the range; although in the valley of the north fork of Yuba River, its lower limits nearly coincide with the upper range of *E. multiscapoideum* (Kell.) Nelson & Kennedy, which finds its way up through the yellow pine belt. With more detailed exploration in Tuolumne County, it may be found at or near the upper limits of *E. tuolumnense* Applegate.

Specimens collected. Upper Kings Meadow, Mt. Lassen region, Shasta County, 20 June 1929, *5772;* Drakesbad, Warner Valley, Mt. Lassen region, Plumus County, 21 June 1929, *2802.*

Specimens examined. California. Shasta County: Lassen Peak, August 1896, *Mrs. Austin 531* (UC); 7 July 1897, *M. E. Jones* (DH); Kings Valley, 3 August 1896, *Mrs. Austin* (US); Soupan Springs, June 1903, *Hall & Babcock 4294* (US, GH, NY, UC). Plumas County: Indian Valley, 1875, *J. G. Lemmon 627* (UC); Massac Creek, 18 June 1919, *W. W. Wagner 260* (DH); Crystal Lake, 25 May 1920, and Greenville, 3 April 1920, *Mary Clemens* (CA); near Long Valley, 15 June 1927, *Alice Eastwood 14534* (CA, NY); Lake Center, 15 July 1921, *Anna Head* (CA); Drakesbad, Mt. Lassen, June 1927, *Mrs. Sutliffe* (CA); Feather River Meadows, April 1897, *Mrs. R. M. Austin 906* (US); July 1911, *W. W. Eggleston 7241* (US); Hotspring Valley, *Jepson 4079* (US); without definite locality, 1872, *Mrs. M. E. P. Ames* (US), 1874 (GH), without date (GH, NY); *Mrs. Austin* (US), 1876–7 (GH). Lassen County: Big Meadows, April 1878, *Mrs. R. M. Austin 287* (UC). Tehama County: Lassen Butte, August 1912, *Alice Eastwood* (CA); Dry Lake, 13 July 1911, *W. W. Eggleston 7210* (US, NY). Sierra County: Cedar Glen, 25 May 1920, *V. Jones* (CA); Lusk Meadows, July 1918, *Mrs. Sutliffe* (CA); Downieville, 21 May 1853–4, *J. M. Bigelow* (PhA, GH, US, NY, the last the type of *E. grandiflorum* var. *multiflorum* T. & G.); hills near Forest City, 21 May 1853–4, *J. M. Bigelow* (US, GH, type of *E. grandiflorum* var. *uniflorum* S. Wats.). Placer County: Cisco, 17 June 1917, *Heller 12685* (DH, CA, US, PhA, GH, NY); 6 July 1923, *Miss Raphael* (CA); Duncan Canyon, 26 May 1926, *L. S. Smith 1867* (CA); Robertson Flat, August 1927, *W. W. Eggleston 21566* (NY). Nevada County: Donner Lake, June 1900, *W. R. Dudley* (DH). Calaveras County: Highland Creek, 3 July 1930, *M. S. Jussel* (CA). Madera County: Shuteye Mountain, 22 August 1907, *J. Murdoch Jr. 554* (US, GH, NY, CA). Tuolumne County: Wheats Meadow Trail, *W. W. Eggleston 9383* (US). Tulare County: Mt. Moses, June–July 1895, *Purpus 1341* (UC).

Type locality: "In the Sierra Nevada: near Downieville, Sierra Co. (Dr. J. M. Bigelow), and frequent in Plumas Co., whence fine specimens have been received from Mrs. M. E. Pulsifer Ames, and from Mrs. R. M. Austin." The type was collected on "hillsides near Downieville, California, May 21," by Dr. J. M. Bigelow while acting as surgeon and botanist to the

Whipple railway exploring expedition of 1863–4. From this collection also, came the type of Dr. Torrey's *E. grandiflorum* var. *multiflorum*, described by him as "stigmate clavato-capitato" which properly characterizes that organ of *E. purpurascens*.

On the same date as the last, Dr. Bigelow collected on "hills near Forest City," Sierra County, the plant referred by Torrey (Pac. R. R. Rep. 4: 145) to *E. grandiflorum* Pursh.; his description, "stigma is manifestly 3-cleft" correctly describes that organ of *E. multiscapoideum* (Kell.) Nelson & Kennedy, and the specimens of this collection in the Torrey Herbarium (New York Botanical Garden) are clearly of that species. But, on the other hand, in an examination of the Bigelow collections in the National Herbarium, Gray Herbarium, and that of the Philadelphia Academy of Sciences, I find that Dr. Torrey did not include in his distribution any material of *E. multiscapoideum* (Kell.) Nelson & Kennedy; but, instead, evidently under the impression that the specimens were of the same species, sent out one-flowered specimens of *E. purpurascens* under *E. grandiflorum* Pursh., designating a collection of very small sized plants as a variety of the same. A specimen of the larger plant in the Gray Herbarium is the type of *E. purpurascens* var. *uniflorum* S. Wats. Besides the confusion as to identity of species, it seems likely that there was a misunderstanding as to locality. "Forest City" is about ten miles south of Downieville on the divide between the middle fork and the south fork of Yuba River, in the early mining days a station on the old stage road to Nevada City. I suspect from my observations in the region, that the only species of *Erythronium* found by Bigelow in that vicinity was *E. multiscapoideum* (Kell.) Nelson & Kennedy; all the rest of his collections of the region being *E. purpurascens* from near Downieville, both the single- and multiple-flowered ones.

Dr. Alfonso Wood (Proc. Phila. Acad. 1868: 166) records having collected in 1866, in the vicinity of Downieville, an *Erythronium* which he referred to *E. grandiflorum* var. *multiflorum* Torr.

2. Erythronium klamathense Applegate, Contr. Dudley Herb. 1: 151. 1930.

Corm narrowly oblong, 3–5 cm. long, 7–10 mm. thick; leaves commonly lanceolate and very acute, frequently broader, the larger one sometimes oblanceolate and obtuse, attenuate to a narrow base, lustrous yellow-green, 7–15 cm. long, 1.5–2.5 cm. broad, rarely narrower; scape about 7–20 cm. high; flowers usually solitary but occasionally 2 or 3 to several on rather long pedicels of unequal length; perianth segments lanceolate to broadly lanceolate, acuminate, acute or the outer set acutish, 20–25 mm. long, about 5 mm. broad, the upper half or two-thirds pure milk-white, the lower part pure yellow; the auricles and basal processes always present and well developed, the

median pair, globularly inflated, the lateral ones about the same size but usually with less inflation; filaments slender, very slightly dilated below, evenly attenuate upward, about half as long as the young yellow anthers; style short and rather strongly clavate; stigma practically entire or indistinctly toothed; capsule obovoid, about 3 cm. long, 2 cm. thick.

Type in the Dudley Herbarium, no. 199386, collected among lodge-pole pines, Canadian Zone, at the south end of Four Mile Lake, near the east base of Mt. Pitt, Cascade Mountains, Klamath County, Oregon, 2 June 1926, *Applegate 4676*.

The following additional numbers were collected by myself in Oregon, and are deposited in the Dudley Herbarium of Stanford University. Jackson County: Burnt Creek, Cascade Mountains, 1 June 1895, *711;* eastern terminus of the Siskiyou Mountains, 24 May 1898, *2273;* 9 June 1925, *4359*, *4360;* summit of Green Spring Mountain, 22 May 1924, *4089, 4090;* Table Mountain, 16 May 1925, *4267, 4269, 4270;* Hyatt Prairie, 16 May 1925, *4272;* 29 April 1926, *4609;* Grizzly Peak, 19 May 1926, *4641, 4642, 4647;* Dead Indian Divide, 19 May 1926, *4648;* Dead Indian road, 20 May 1926, *4652;* Grizzly Prairie, 20 May 1926, *4653;* Pilot Rock, Siskiyou Mountains, 9 June 1928, *5448;* 18 June 1928, *5541*. Klamath County: Four Mile Lake, 2 June 1926, *4669, 4674, 4680, 4682;* Badger Lake, 2 June 1926, *4683;* Long Lake, 2 June 1926, *4684, 4685;* Sky Lakes, 19 July 1929, *6078*. Douglas County: Hershberger Mountain, 11 July 1929, *5936, 6033*.

Specimens examined. OREGON. Jackson County: Abbotts Butte, 6 July 1897, *J. B. Leiberg 4230* (UO, US); Dead Indian Mountain, 6 May 1925, *A. R. Sweetser* (UO); Burnt Creek, Cascade Mountains, 1 June 1895, *Applegate 711* (GH, US); junction Siskiyou and Cascade mountains, 24 May 1898, *Applegate 2273* (GH, US, NY). Klamath County: Four Mile Lake, 20 June 1898, *Applegate 2508* (US); Mt. Pitt, 27 July 1897, *Coville & Applegate 216* (US). CALIFORNIA. Siskiyou County: Castle Lake, 19 June 1893, *W. R. Dudley* (DH, NY); 28 July 1911, *I. J. Condit* (UC); 24 July 1921, *Alice Eastwood* (CA).

Definitely separated geographically from its nearest ally, *E. purpurascens* S. Wats., and readily distinguished from that species by the always present and well developed segment processes, a much more lax inflorescence, fewer, larger, and less delicate flowers, broader perianth segments, shorter capsule and differently colored anthers.

Flowering in its lower limits early in the season, immediately after the disappearance of the snow, and following its retreat to higher levels with the advance of the season. This species is easily grown and very responsive to cultivation. Plants grown in my garden at Klamath Falls, flowered earlier than the other endemic species of southern Oregon.

Distribution: from the vicinity of Pilot Rock, Jackson County, Oregon, the species extends eastward along the summit of the Siskiyou Mountains to their junction with the Cascade range, on the brink of the canyon of the Klamath River, in the southeast corner of Jackson County, ranging between 5000 and 6000 feet altitude, Canadian Zone, abundant on steep northerly slopes, in openings in the heavy white fir forest; thence northerly through the higher parts of the Cascade Mountains to the Sky Lakes region, Klamath County, west of Klamath Lake, where it occurs abundantly in the lodgepole pine and black hemlock forests, 6000 to 7000 feet altitude, Canadian and Hudsonian zones; appearing again north of Rogue River along the Rogue-Umpqua Divide between Abbott Butte and Hershberger Mountain, southern edge of Douglas County, in the forest of sub-alpine and Shasta fir, and on the summit of Hershberger Mountain among clumps of Alaska cedar at over 6000 feet altitude. From the Dead Indian region, it ranges westward along a spur of the Cascades to the summit of Grizzly Peak, overlooking the Rogue River Valley east of Ashland and Medford. Known only from one station in California, Castle Lake, north end of the Trinity Mountains, Siskiyou County, all of the specimens of which have heretofore been referred to what is now known as *E. grandiflorum* var. *pallidum* St. John. It is interesting to note that the first collection was made by the late Dr. W. R. Dudley, Professor of Botany, Stanford University, after whom Dudley Herbarium was named. This is the southernmost station of the species. It is separated from the northern limits of *E. californicum* Purdy by the Trinity and Scott mountains, and is in the same general region as the southern limits of two other Siskiyou Mountain species, *E. citrinum* S. Wats. and *E. Hendersonii* S. Wats. as well as that of *E. grandiflorum* var. *pallidum* St. John which occurs on the Trinity summits. About 30 miles to the southeast, across the valley of the Sacramento River, is Mt. Lassen, the northern outpost of *E. purpurascens* S. Wats., nearest of kin to the Klamath *Erythronium*. When the distributional details of the California range of the species are worked out, this range may be found to be more closely connected with that of Oregon.

In its whole range *Erythronium klamathense* Applegate rarely extends down to the 5000 foot level, and then only under favorable conditions of slope and shade; while, on the other hand, *E. Hendersonii* S. Wats. is sometimes found extending up to this level in more exposed situations. The two species are rarely found in close contact, and in only one place have I seen unmistakable examples of hybridization between them. The only other species with which it is ever associated is *E. grandiflorum* var. *pallidum* St. John. On the Umpqua-Rogue Divide these two species mingle freely and are in flower at the same time. Whether or not they hybridize, I have not as yet been able

to determine with certainty, although I am inclined to think they do.

3. Erythronium nudopetalum Applegate, Contr. Dudley Herb. 1: 189. 1933.

Corm small and slender, about 4 cm. long, 5 mm. thick; mature scapes not more than 15 cm. high; leaves commonly oblanceolate or sometimes lanceolate, rather narrow, acute, attenuate at the base without evident petiole; flowers small, the segments less than 25 mm. long, 3–4 mm. wide, narrowly lanceolate, acuminate, golden-yellow more or less streaked with green, especially on the outside, the bases of the inner ones naked; filaments slender, thin, attenuate, equaling the young anthers; anthers long, dark red or maroon; style slender, shorter than the young stamens; stigma practically entire or occasionally obscurely lobed or toothed.

Type in the Dudley Herbarium of Stanford University, collected on the north slope of the Sawtooth Mountains, Idaho, in a wet subalpine glade in a forest of lodgepole pine and subalpine fir, at the head of Bear Valley Creek, a branch of the middle fork of Salmon River, Custer County, *Applegate 6308,* 18 June, 1930. Besides the type, another collection was made on the same date under lodgepole pines in Bear Valley a few miles farther east, *Applegate 6316.*

Known only from these two collections. When the great wilderness region embraced within the upper drainage system of Salmon River is better known botanically, this species will doubtless be found to have a more extended range.

Allied to *E. grandiflorum* Pursh which it superficially strongly resembles, but differing from that species in being entirely destitute of any kind of inner segment appendages, in having an entire or obscurely lobed stigma, and leaves with less evident petioles.

Concerning the stigma difference, it was pointed out by Watson in his revision of the genus (1891), and it has been generally accepted since, that the coherence or divergence of the stigma seems to be a satisfactory basis for the separation of species into two groups, the character being fairly constant in each species. Notwithstanding this conclusion, he goes on to say that even in species with persistently coherent stigmas, it is probable that separation occasionally occurs. That this is the case, I have conclusively proved by extensive field and other investigation. On the other hand, it is also true that in the species having normally long stigma lobes, individuals are occasionally found with short lobes, or even with practically entire stigmas. In the group having entire or obscurely lobed stigmas, the style is usually correspondingly shorter and more strongly clavate; while in the other group the style is long and more slender. In the examination of many plants covering much of the range, I have found

that occasionally the stigma lobes of *E. grandiflorum* Pursh are more or less united, and rarely, almost entirely so. This is also true, but to a lesser degree, in *E. grandiflorum* var. *pallidum* St. John, especially east of the Cascade Mountains. West of that range the normal long lobed, strongly recurved stigma is more constant. In the mountains of northern Utah, in both *E. grandiflorum* Pursh and *E. grandiflorum* subsp. *chrysandrum* Applegate, the lobes are normally shorter, and not infrequently quite short and stubby to even obscurely lobed. The same thing is true of the latter in the Rocky Mountain region of Colorado and southern Wyoming, this being, apparently, the only form found there. Also in the last two regions mentioned, the style is stouter and more strongly clavate, suggesting a further approach toward the other group. In the case of *E. nudopetalum,* the stigma differentiation is carried to the point where the lobed stigma is the exception. In the other related species, *E. idahoense* St. John & Jones, the obvious difference is in the color of flower. The whole group seems to be in a plastic stage, tending toward differentiation and segregation into more or less isolated geographic units; with the white-anthered form occupying an exclusive position on the western front, the yellow-anthered one holding the same place on the eastern outpost, and the dominant red-anthered plants with the others, usually in separate colonies, widely distributed over the intermontane region.

The diagnostic importance of the presence or absence of inner-segment processes is discussed under *E. Howellii* S. Wats. another species with naked segments.

4. Erythronium tuolumnense Applegate, Contr. Dudley Herb. 1: 153. 1930.

Corm very large with copious loose membranaceous coats, about 6 cm. long, 2 cm. thick, propagating by sessile or nearly sessile offsets from the base or side, producing compact clusters or clumps; leaves not mottled, lustrous yellow-green, unusually large, from lanceolate, acute to very broadly oblanceolate with rounded apex, 2–3 dm. long, 4–8 cm. broad, gradually narrowed to a long winged petiole; scapes bright green, longer than the leaves, sometimes more or less tortuous, one to several flowered, usually approximate; segments lanceolate to oblong-lanceolate, about 30 mm. long, 8–10 mm. broad, acute or acutish, deep golden-yellow with pale greenish-yellow base gradually fading into nearly white below, the median basal processes rather well developed, the lateral ones smaller or wanting, the auricles slightly folded into a ridge; style slender, narrowly clavate and of medium length, about 10 mm. long; stigma practically entire or sometimes very shortly toothed; young anthers deep golden-yellow, about 10 mm. long, old ones about one fourth as long; filaments slender, the two sets markedly different in length, the

outer 6 mm., the inner 9 mm. long, or occasionally, the inner about twice the length of the outer; capsule obovoid, retuse.

Type in the Dudley Herbarium of Stanford University, no. 199388, collected in open yellow pine and oak woods on steep north slope of the canyon wall of the south fork of Stanislaus River, about half a mile below Italian Bar, Tuolumne County, California, altitude about 300 m., *Applegate 5549*, 26 April 1929.

The following collections were cited in the original publication of the species: in the Dudley Herbarium, *Adele Lewis Grant 633*, Five Mile Creek, and Standard City, Tuolumne County, "sent to the Annual Wild Flower Show by the Standard School, April 23, 1922"; from the University of California, *Fred Grant*, Italian Bar; *Jepson 6407*, Yankee Hill, Tuolumne County. Another collection in the same herbarium was examined recently (Keltz Mine, 7 June 1895, *W. C. Blasdale*), and referred to *E. purpurascens* S. Wats. as recorded by Dr. and Mrs. H. M. Hall in "A Yosemite Flora" (p. 57). This seems to be the earliest recorded collection of the species, the station being only a short distance above the type locality. All the other collections were referred to the wholly unlike Siskiyou Mountain endemic, *E. citrinum* S. Wats. Basin Creek, 16 Mar. 1932, *Helen Jorgensen* (CA).

Of all our western species this one stands out as the most distinct. Most remarkable is the extent to which the underground vegetative reproduction is carried on by which the corms are multiplied many times by offsets. In the moist soil, enriched by deep leaf-mold this takes place rapidly, often producing closely packed clumps of from several to half a hundred or more corms. The only other of our western species to share in this habit to any extent is another very local species, *E. helenae* Applegate, although not so commonly or to the same extent, except under the stimulus of irrigation and cultivation. Of the eastern forms, *E. mesachoreum* Knerr. seems to be the only one to reproduce in like manner, the others which grow offsets producing the corms on the ends of long, filiform runners as in our western *E. multiscapoideum* (Kell.) Nelson & Kennedy.

This remarkable and extremely local species is known only from a few isolated colonies in southwestern Tuolumne County. Although long known, and collected by a number of botanists, curiously enough it was not recognized as something entirely new.

Comparatively few of the flowers mature seed pods, the plant expending much of its energy in the vegetative reproduction already referred to.

The shrinkage of the anthers in dehiscence is unusually great, being about three fourths, while in all other species with which I am acquainted, it is approximately one half; and the difference in length of the filaments in the two sets is greater than normal, the inner being sometimes nearly twice that of the outer.

5. Erythronium grandiflorum Pursh, Fl. Am. Sept. 1: 231. 1814. *Erythronium giganteum* Lindl. Bot. Reg. sub. pl. 1786. 1835. *Erythronium grandiflorum* var. *giganteum* Hook. Fl. Bor. Am. 2: 182. 1840. *Erythronium grandiflorum* var. *albiflorum* Hook. Fl. Bor. Am. 2: 182. 1840. *Erythronium grandiflorum* var. *minus* Hook. Fl. Bor. Am. 2: 182. 1840. *Erythronium Nuttallianum* Regel, Gartenfl. 20: 227, pl. 695, figs. 1, 2. 1871. Not *E. Nuttallianum* R. & S. which equals *E. americanum* Ker-Gawl. *Erythronium grandiflorum* var. *parviflorum* S. Wats. Proc. Am. Acad. 26: 129. 1891. As to citations, otherwise in part by inference. *Erythronium obtusatum* Goodding, Bot. Gaz. 33: 67. 1902. *Erythronium utahense* Rydb. Fl. Rocky Mts. 165, 1061. 1917. *Erythronium leptopetalum* Rydb. Fl. Rocky Mts. 165, 1061. 1917.

Corm long and slender; leaves 10–20 cm. long, usually oblong-elliptic, acute to acutish, sometimes more or less oblanceolate and obtuse, all attenuate to a narrowly winged petiole; scape 15–30 cm. or higher; flowers one to several, the segments lanceolate, acuminate acute or sometimes blunt, 20–35 mm. long, 4–7 mm. broad, golden-yellow, the base lighter within and streaked with green without, the basal appendages well developed, commonly nearly equal, globular but not often very strongly inflated, definitely auricled; filaments usually only slightly wider below; anthers dark red or maroon; style long and slender, slightly enlarged upward or sometimes stouter; stigma usually with long, strongly recurved lobes or occasionally shorter to rarely nearly entire lobes; capsule obovoid, more or less retuse, about 30 mm. long, 10 mm. thick.

This was the second of our western species of *Erythronium* to be found, and like the first, is of added interest because of its historical setting. The original specimens were collected in the Clearwater region within the present state of Idaho by Meriweather Lewis. This was on the return trip of the memorable Lewis & Clark expedition of exploration to the Pacific coast. Two collections were made by Lewis, the first "From the plains of the Columbia near Kooskooskie River, May 8, 1806." This was south of the river and nearly opposite the south fork. On this day the expedition ascended the high precipitous wall of the canyon of the Kooskoosky or Clearwater River, to the high tableland, traveling only about 6 miles to a point about the same distance north of the present town of Craigmont in Lewis County, a region of grassy plains and scattered yellow pines. Lewis referred to this plateau region as "the plains of the Columbia." The second collection was made at "Camp Chopunnish" on the Kooskoosky River, June 5, 1806, which has been generally considered to be the type locality. Pursh in his original publication, says: "On the Kooskoosky. *M. Lewis* . . . May, June, *v. s.*" From the dates it might be inferred that he considered both collections. This camp opposite the present town of Kamiah,

Lewis County. The expedition spent nearly a month here waiting for the snow to melt sufficiently for a passage over the Bitterroot Mountains.

During the month of May, 1931, I explored this region for the purpose of clearing up the uncertainty as to the color of the anthers of the plant collected by Lewis. As he recorded in his journal, the Erythroniums were in "full blume" and in great abundance "on the plains of the Columbia," and although I examined many specimens along the trail of the expedition across the plains and all the way to Kamiah, I found none with white anthers, and rarely a sporadic individual with yellow anthers; so that it seems reasonable to conclude that both of Lewis's collections had red anthers, the form now generally accepted as typical *E. grandiflorum* Pursh.

The plants of the Lewis & Clark expedition were delivered by Lewis in person to Thomas Jefferson, President of the United States, who cared for them for a time and then turned the collection over to the American Philosophical Society at Philadelphia, which in turn finally deposited it with the Philadelphia Academy of Natural Sciences, founded in 1812. Here the collection was lost for about 75 years. When the specimens were recovered from an old closet, much damage had been done by insects.

The following published illustrations are of interest in a discussion of this species. In Lindley's Botanical Register, plate 1786, 1836, is a fine cut showing a plant with golden-yellow flowers with red anthers and plain vivid green leaves, without doubt the plant so abundant in the vicinity of Kamiah, Idaho, and the region thereabouts. In the text accompanying the plate, Lindley states: "Of this extremely rare plant, a single bulb was received by the Horticultural Society from North West America eight or nine years ago; it has continued to grow slowly in a peat border, and at last put forth its beautiful flowers last May. . . . Mr. Douglas, who discovered it, considered it the *Erythronium grandiflorum* of Pursh; and we adopt his opinion. . . ." Reference to Douglas' journals would indicate that the bulb referred to by Lindley was collected near Ft. Colville, Kettle Falls, Columbia River, Washington, in 1827. *E. Nuttallianum* Regel is another colored cut showing the same plant, and was cited by Watson in his original publication of *E. grandiflorum* var. *parviflorum;* which citation is discussed under *E. grandiflorum* var. *pallidum* St. John.

Distribution: Hudsonian, Canadian and Transition zones. From the Rocky Mountain region of Idaho, Montana, northern Wyoming and the Wasatch Mountains of Utah, westward through the mountains and adjacent foothills of northern Oregon and of Washington, to the eastern slope of the Cascade Mountains; with an altitudinal range of from about 400 feet along the Columbia River in eastern Hood River and western Wasco counties, Ore-

gon, and eastern Klickatat County, Washington, to above 9000 feet on the slopes of Mt. Washburn, Yellowstone National Park, Wyoming. The center of greatest abundance is perhaps in the yellow pine belt in the western foothills of northern Idaho where the species is found in extensive colonies and in great abundance in open woods, cutover lands, prairies and cultivated fields. When occupying the same region with other forms of the species, they are usually found in separate colonies, although occasional contacts are made. Rarely individuals of all three forms (red-, white- and yellow-anthered) are found growing in the same colony. In some cases hybrids were observed.

The following collections were made by myself. Oregon. Hood River County: Columbia River near Hood River, 6 May 1931, *6795, 6794*. Wasco County: Mosier, 6 May 1931, *6796*. Baker County: Blue Mountains above Sumpter, 14 June 1930, *6242, 6250*. Washington. Chelan County: Blewett Pass, Wenatchee Mountains, 24 April 1931, *6685*. Idaho. Fremont County: Snake River, near Henry Lake, 22 June 1930, *6358;* Targhee Pass, Continental Divide, 22 June 1930, *6362*. Bonner County: Hope, Pend Oreille Lake, 27 April 1931, *6703*. Kootenai County: Rathdrum, 26 April, 1931, *6702;* Coeur d' Alene, 28 April, 1931, *6709;* 5 miles southeast of Coeur d' Alene, *6710;* between Ford and Worley, 28 April 1931, *6712*. Nez Perces County: Near Culdesac, 1 May 1931, *6718*. Lewis County: between Culdesac and Winchester, 1 May 1931, *6721;* Winchester, 3 May 1931, *6760a;* Wilson Canyon near Kamiah, 3 May 1931, *6755;* between Nez Perces and Craigmont, 3 May 1931, *6758*. Idaho County: Clearwater River near Kamiah, 2 May 1931, *6729;* Lowell, middle fork of Clearwater River, 2 May 1931, *6738*. Wyoming. Yellowstone National Park: Targhee Pass, Continental Divide, 22 June 1930, *6363;* Continental Divide west of Yellowstone Lake, 23 June 1930, *6370;* Yellowstone Lake, 23 June 1930, *6371;* Mt. Washburn, 23 June 1930, *6373*. Utah. Salt Lake County: Mt. Olympus, 10 June 1934, *8402, 8408*.

Specimens examined. Oregon. Hood River County: near Hood River, 1 April 1923, *M. W. Gorman 6008* (DH, PhA), 12 March 1884, *L. F. Henderson* (UO, OS), 10 April 1924, *Kirk Whited 1069* (NY, PhA, GH). Wasco County: Mosier, 9 April 1893, *Thos. Howell* (UC, UO, UWy, DH). Baker County: above Sumpter, 6 July 1919, *Ferris & Duthie 875* (DH, UWy); Powder River Mountains, 1874, *Rev. Nevius* (GH). Wallowa County: near Bear Creek, 5 June 1907, *F. V. Coville 2383* (US). Washington. Whitman County: Pullman, 6 May 1893, *F. L. Moore* (WS), 25 April 1894, *Piper 1676* (PhA, GH, US, DH, WS, NY), Union Creek, 6 April 1922, *C. S. Parke* (WS). Spokane County: Hangman Creek, 24 May 1893, *Sandberg & Leiberg* (WS, UO, GH, US, NY). Stephens County: near Ft. Colville, 1861, *Lyall* (GH). County unknown, probably in 1833, "Columbia Plains," *Wyeth* (GH). Walla Walla County: Waitsburg, 17 April 1897,

R. M. Horner B483 (GH, US). Yakima County: Simcoe Mts., June 1879, *J. Howell* (GH); Yakima region, 1882, *T. S. Brandegee 191* (PhA). Chelan County: Blewett Pass, 18 April 1931, *J. W. Thompson 5998* (GH, US); Chiwaukam Creek, 19 May 1928, *St. John & Eggleston 21940* (US). Klickitat County: western part, April–May 1881, *W. N. Suksdorf 146* (US, PhA). IDAHO. Bonner County: Warren Island, Lake Pend Oreille, 5 April 1904, *M. B. Dunkle 349* (UI); Lake Pend Oreille, May 1891, *J. B. Leiberg* (UO); Hope, 1 April 1914, *Dunkle 338* (UI, UWy). Latah County: Moscow, 1917, *F. W. Gail* (UI), 6 April 1900, *L. R. Abrams 539* (DH, UC, NY), 1894, *L. F. Henderson* (US); Potlatch, *G. W. Goodwin* (UI). Fremont County: near St. Anthony, 20 June 1919, *E. H. Quagh 89* (DH, UWy, NY); near Henry Lake, 21 June 1899, *Nelson & Nelson 5480* (DH, UC, UWy, GH, US, NY). Custer County: Challis National Forest, 25 May 1928, *L. B Koch* (UU). Lemhi County: Salmon, 1 July 1920, *E. B. & L. B. Payson 1862* (UWy, GH, NY), 10 June 1896, *J. S. Kemp* (NY). Nez Perces County: near Lake Waha, 20 May 1892, *Sandberg, MacDougal & Heller 202* (GH, PhA, US, NY); Clear Water, *Rev. Spaulding* (about 1840) (GH); between Culdesac and Craigmont, 17 April 1933, *M. S. Baker 7400*. Boise County: Dry Buck, 10 May 1911, *J. F. Macbride 848* (US, NY, GH); near Boise City, June 1881, *T. E. Wilcox* (GH); near Boise, June 1892, *Ishabel Mulford,* type of *E. leptopetalum* Rydb. (NY). Shoshone County: between St. Joe and Clearwater River, 11 July 1895, *J. B. Leiberg 1257* (US). Owyhee County: Hotsprings, 2 July 1895, *L. F. Henderson 3101* (US). Kootenai County: Coeur d' Alene, May 1912, *H. J. Rust 3* (US), June 1890, *J. B. Leiberg* (NY). MONTANA. Gallatin County: Mystic Lake, 25 July 1895, *C. L. Shear* (US, NY); Bridger Peak, 25 May 1900, *V. K. Chesnut and W. W. Jones 198a* (US), 18 June 1897, *Rydberg & Bessey* (UM, UWy, MS, GH, US, NY); near Bozeman, *J. W. Blankenship* (UM); Gallatin Forest, 21 May 1922, *W. A. Chippenfield* (UM); Middle Creek Canyon, 26 July 1897, *D. B. Swingle* (UWy); Bozeman Pass, 2 June 1883, *W. M. Canby 323* (GH, PhA, US), 28 May 1883, *F. L. Scribner 283* (GH, PhA); Bozeman, 1907, *Hattie M. Hodgman* (GH); Bald Mountain, 22 July 1880, *S. Watson 417* (GH, US); Limekiln Canyon, 1 June 1905, *Blankenship 475* (PhA). Powell County: Deer Lodge, *Mrs. L. A. Fitch* (UM), May 1888, *F. M. Traphagen* (NY). Madison County: Sheridan, July 1896, *H. M. Fitch,* (UM, DH, NY); Madison Valley, May 1814, *Glen Conkling* (UM), 8 July 1871, *G. N. Allen* (US); Spanish Basin, 18 July 1896, *J. H. Flodman 347* (US, NY), 1 July 1897, *Rydberg & Bessey 3872* (US, NY). Deer Lodge County: *Miss F. I. Hobson* (MS), 5 June 1891, *Professor Merritt* (NY). Park County: Livingston, 1898, *Mrs. Scheuber* (MS), 18 May 1901 *E. W. Scheuber* (US, NY). Missoula County: near Missoula, 12 June 1901, *D. T. MacDougal 158* (US, NY). Judith Basin County: Belt Mts., 28 June 1885, *F. W.*

Anderson 8162 (NY). Lewis & Clark County: Helena, 1 June 1892, *F. D. Kelsey* (NY). Wyoming. Yellowstone National Park: Buffalo River, 16 June 1930, *Mrs. Van Dyke* (CA); Lake Camp, 19 June 1924, *H. S. Conard 1038* (UWy); Glen Creek, 1 July 1899, *Nelson & Nelson 5606,* type of *E. obtusatum* Goodding (UWy); near Obsidian Cliffs, 20 July 1911, *R. H. Smith* (PhA); Mt. Washburn, 13 July 1902, *E. A. Mearns 1842* (US); Electric Peak, 26 July 1902, *E. A. Mearns 169* (US); 18 August 1893, *J. N. Rose 227* (US); near Mammoth Hot Springs, July 1893, *F. H. Burglehaus* (US); Specimen Ridge, 23 August 1887, *F. H. Knowlton* (US); Swan Lake, June 1885, *Frank Tweedy 505* (US); Corke Lake, 15 July 1888, *F. H. Knowlton* (US). Teton County: Whetstone Creek, 26 June 1929, *O. J. Munie 129* (UWy). Utah. Salt Lake County: Brighton, *V. C. Fish* (UU); Dry Creek Canyon, *J. Goldstein* (UU); Park City, 29 June 1893, *Mrs. Snyder* (UC); Peterson Canyon, 19 July 1902, *Pammel & Blackwood 3860* (GH); base of Wasatch Mountains, 22 April 1904, *A. O. Garrett* (GH); Big Cottonwood Canyon, 13 May 1909, *Mrs. Joe Clemens* (GH, DH); Dry Canyon, 10 June 1908, *Mrs. Clemens* (GH, PhA); Salt Lake City, May 1869, *S. Watson* (GH, US), *A. O. Garrett 997* (US); City Creek Canyon, 20 April 1900, *S. G. Stokes* (US, NY, DH, UC); Wasatch Mts., April 1871, *Nevius* (US); Parleys Peak, July 1869, *S. Watson* (NY); Cottonwood Canyon, July 1869, *S. Watson* (NY); Salt Lake, 1850, *Captain Stansbury,* type of *E. utahense* Rydb. (NY); City Creek Canyon, 11 May 1880, *M. E. Jones* (NY); Big Cottonwood Canyon, 29 June 1905, *Rydberg and Carlton 6506* (NY), 8 June 1920, *A. O. Garrett 2907* (NY); Ft. Douglas, 28 May 1911, *M. E. Jones* (DH, UC); City Creek Canyon, 3 April 1883, *F. E. Leonard* (DH, UC). Rich County: Bear River Canyon, August 1869, *S. Watson 1175* (GH, US); near Bear Lake, 18 June 1932, *Rua Pierson 642* (NY). Weber County: near Ogden, June 1872, *J. M. Coulter* (US). Box Elder County: Bingham, 23 April 1890, *M. E. Jones* (NY). Cache County: 2 May 1909, *C. P. Smith* (DH).

In the publication of his *E. obtusatum,* Goodding cites two collections: Yellowstone National Park, Glen Creek, 1889, *Nelson & Nelson 5606* (type), and Idaho, Continental Divide near Henry Lake, 1899, *Nelson & Nelson 5480* (cotype). Having made collections of many specimens in both localities cited, and carefully examined the type material in the Rocky Mountain Herbarium of the University of Wyoming, together with duplicates and other material in various other herbaria, I can find nothing to distinguish it from *E. grandiflorum.* Goodding's use of filament width is of no value in this connection. In all the forms of *E. grandiflorum* Pursh, there is more or less variation in width of this organ over a very wide range, but it is too indefinite and inconstant to be of diagnostic use.

Rydberg in describing his two species, *E. utahense* and *E. leptopetalum,* uses anther-length as a determining character, which is valueless when we consider behavior in the various stages of anther development, a discussion of which will be found under *E. idahoense* St. John & Jones. The two species described by Rydberg are separated upon the basis of style thickness and segment width, which in the present instance can not be relied upon. In the various forms of *E. grandiflorum* there is considerable variation in the thickness and shape of the style and the length of the stigma lobes. This is more pronounced in the Wasatch Mountains of Utah, and in the Rocky Mountain region of Colorado and southern Wyoming, the stouter and more clavate style and shorter stigma lobes predominating in contrast to the more slender style and longer, more strongly recurved stigma lobes dominant in the intermontane regions, and especially west of the Cascade Mountains. The width of the perianth segment is also variable and not to be relied upon. For example, at Cle Elum, Washington, I found many plants of *E. grandiflorum* var. *pallidum* St. John (*Applegate 6680*) with very narrow segments, even narrower than in the type of *E. leptopetalum* Rydb. The same thing is true of *E. grandiflorum* Pursh around Rathdrum, Idaho (*Applegate 6702*). The type collection of *E. leptopetalum* Rydb. was made by Isabel Mulford near Boise, Idaho, and is deposited in the herbarium of the New York Botanical Garden. This I have examined and found to be what I should say is good *E. grandiflorum* Pursh. While collecting in the type region, I found only that species. The type of *E. utahense* Rydb. is in the same herbarium, and was collected in the spring of 1850 at Salt Lake, Utah, by Captain Stansbury while making a government survey of Salt Lake. Recently I examined the type and many other collections determined by Rydberg as belonging to his species, and made collections and other investigations in the region, from all of which I conclude that *E. grandiflorum* Pursh is the only species in the vicinity of Salt Lake.

E. grandiflorum var. *minus* was evidently applied to small, single-flowered specimens of the type. For many years this name has been used indiscriminately for the various forms of the species, especially for the higher mountain plants, much in the same way as Watson's name *E. parviflorum.* Watson (l.c. 1891) says that this is the same as the name used by Morren and others (*E. grandiflorum* var. *minus* Morren Belg. Hort. 26: 109, t. 6. 1886).

5a. Erythronium grandiflorum var. pallidum St. John. Research Stud. St. Col. Wash. 2: 113. 1931. *Erythronium grandiflorum* Pursh var. *parviflorum* S. Wats. Proc. Am. Acad. 26: 129. 1891, in part by inference, but not as to type. *Erythronium*

parviflorum Goodding, Bot. Gaz. 33: 67. 1902, in part as to nomenclature, but not as to type.

Differs from the type in having white anthers instead of red ones, unequal filament lengths in each set, and stigma lobes which perhaps average slightly longer.

In *E. grandiflorum* Pursh and all other species of the genus with which I am familiar, the filaments in each set are normally of equal length, those of the outer set being the shorter. In the examination of a great number of plants over practically the entire range of this widely distributed white-anthered form, I have found this irregularity to be fairly constant. Rarely they are regular, and occasionally the filaments are all of the same length.

Type: "Washington, rock-slide near snow-bank, Horseshoe Basin, Chelan County, July 13, 1923, *H. St. John and L. Ridout 3670* (type in Herb. State College of Washington)."

Zonal distribution: eastward from the Cascade Mountains, Hudsonian, Canadian and Transition, the same as that of the typical form; westward from the Cascade Mountains, Hudsonian and Canadian.

Geographical distribution: the coast ranges and Klamath Mountains of northwestern California, the Siskiyou and coast ranges of Oregon, the Olympic Mountains of Washington, the higher parts of the mountains of Vancouver Island, all of the mountains of the mainland of southern British Columbia and southwestern Alberta, throughout the Cascade Mountains of Oregon and Washington, eastward through the Blue and Wallowa mountains of northern Oregon, the hills and mountains of eastern Washington to the Rocky Mountain region of Idaho and Montana. It seems rather remarkable that this form should occur in the region west of the Cascade Mountains to the entire exclusion of the typical form, and that it should be there restricted to the higher parts of the mountains. It is also interesting to note that in the Rocky Mountains of Wyoming and Colorado and the mountains of northern Utah, it is replaced by the yellow-anthered form, *E. grandiflorum* subsp. *chrysandrum* Applegate, which also has a high altitudinal range.

Specimens collected. OREGON. Wallowa County: Paradise, 3 July 1930, *6485*. Union County: near Wallowa River, 4 July 1930, *6502*. Umatilla County: Meacham, Blue Mts., 5 July 1930, *6512*. Hood River County: Mt. Hood, 14 August 1932, *8258, 8273*. Douglas County: Hershberger Mt., Cascade Mountains, 11 July 1929, *5937;* Rabbit Ears, Cascade Mountains, 13 July 1929, *6018*. Josephine County: Mt. Grayback, Siskiyou Mountains, 13 June 1927, *5062, 5063;* 16 June 1927, *5081, 5086;* 17 July, 1933, *8766*. Klamath County: near Government Camp, Crater Lake National Park, 22 August 1933, *8826*. WASHINGTON. Asotin County: near Anatone, 30 June 1930, *6457*. Kittitas County: Cle Elum, 24 April 1931, *6680;* Blewett Pass, Wenat-

chee Mountains, 24 April 1931, *6683*. Chelan County: Blewett Pass, 24 April 1931, *6684, 6685a*. Klickatat County: Warwick, 6 May 1931, *6792*. MONTANA. Granite County: Georgetown Lake, 26 June 1931, *6411;* Skalkaho road, continental divide 27 June 1931, *6423*. IDAHO. Bonner County: Athol, 28 April 1931, *6706*. Kootenai County: Rathdrum Prairie, 28 April 1931, *6707;* Coeur d'Alene, 28 April 1931, *6708*. Valley County: Payette River watershed, Sawtooth Mountains, 18 June 1930, *6304, 6307*.

Specimens examined. OREGON. Wasco County: Mosier, 7 April 1928, *J. W. Thompson 4053* (DH, GH, PhA, US); Cascade Mountains, 18 April 1903, *J. Lunell 27* (GH). Hood River County: Mt. Hood, 6 August 1927, *J. W. Thompson 3503* (DH, PhA); Elk Cove, Mt. Hood, 17 August 1927, *Carl English Jr. 858* (WS); Mt. Hood, 17 August 1917, *Mrs. M. P. Russell* (GH), Sept. 1882, *Mrs. P. G. Barrett 37* (GH), 21 June 1924, *L. F. Henderson 804* (GH); near Hood River, 7 April 1928, *J. W. Thompson 4048* (PhA, US, GH, DH). Lane County: Bohemia Mountain, 2 May 1926, *J. R. Patterson* (UO); Cascade Mountains, 6 June 1928, *V. F. Macduff* (PhA). Curry County: Game Lake, 30 June 1929, *Mrs. Leach 2400* (UO). Benton County: west of Corvallis, 28 June 1920, *A. N. Stewart* (UM); Mary's Peak, 27 April 1918, *W. E. Lawrence 1431* (DH), 10 May 1914, *H. C. Gilbert* (OS, UC), 15 May 1921, *M. E. Peck 10842* (PhA). Jackson County: Mt. Ashland, 29 June 1929, *Kildale & Gillespie 8055* (DH). Josephine County: Oregon Caves, 28 May 1928, *Mrs. Leach* (UO); Mt. Grayback, 15 June 1904, *C. V. Piper 6232* (CA, GH); Red Mountain, Siskiyou Mountains, 14 June 1898, *J. B. Leiberg 4069* (UO, US). Klamath County: Vidae Ridge, Crater Lake National Park, 27 June 1928, *Lyle Wynd 2066* (UO). Grant County: Canyon City, 26 May 1927, *L. F. Henderson 8834* (UO). Wheeler County: Canyon Creek, *L. F. Henderson 5120*, 4 May 1925 (UO, GH). Umatilla County: near Meacham, 10 May 1928, *Mrs. N. P. Gale 253* (GH, PhA, US). Union County: 1881, *W. C. Cusick 70* (GH). Gilliam County: near Condon, 10 May 1928, *Mrs. N. P. Gale 258b* (PhA). Douglas County: Abbott's Butte, 29 June 1898, *Applegate 2601* (US). WASHINGTON. Jefferson County: Olympic Mountains, June 1914, *A. D. E. Elmer* (UO), 23 July 1929, *Maj. Nation* (PM). Okanogan County: Sheep Mountain, 1 August 1916, *W. W. Eggleston 13287* (US). Pierce County: Mt. Rainier, July 1922, *L. R. Abrams 9156* (DH), July 1896, *J. B. Fleet* (UC), 1899 (US), August 1895, *C. V. Piper 2100* (GH, US), *Lyman Benson 2305* (NY); Goat Mountains, 23 July 1894, *O. D. Allen 82* (DH, UC, WS, GH, US, NY). Kittitas County: Cle Elum, 4 May 1929, *Lyman Benson* (DH); near Ellensburg, 24 April 1897, *K. Whited* (WS); Klickatat hills, April 1895, *Howell* (UO); near Lauderdale, 18 April 1931, *J. W. Thompson 6028* (GH, US); Teanaway Creek, 26 July 1928, *K. Whited 765* (GH); Swauk River, 1913,

S. P. Sharples 35 (GH, NY); Wenatchee Mountains, 20 June 1903, *J. S Cotton 1206* (PhA, US); Cle Elum, 1897, *Kirk Whited* (US). Clallam County: Olympic Mountains, June 1900, *A. D. E. Elmer 2491* (DH, WS, UO, US, NY). Asotin County: near Anatone, 30 May 1928, *St. John & Palmer 9593* (WS). Skamania County: Mt. Adams, 9 August 1894, *F. E. Lloyd* (NY). Chelan County: Horseshoe Basin, 13 July 1923, *St. John & Ridout 3670*, type (WS); Beverly Creek, near Mt. Stewart, 16 May 1931, *J. W. Thompson 6393* (GH); Dirtyface Mt., 24 June 1932, *J. W. Thompson 8554* (NY). Snohomish County: Silverton, 1899, *Mrs. Bouch* (WS); Mt. Dickerman, 17 July 1932, *J. W. Thompson 8829* (NY). Yakima County: above Chinook Pass, 25 June 1926, *F. I. Pickett 1361* (WS). Klickatat County: Appleton, 5 May 1911, *R. K. Beatty* (WS). Pend Oreille County: Dolkena, 11 May 1923, *C. H. Spiegelberg 83* (WS). Garfield County: near Pomeroy, 2 May 1921, *W. D. Courtney* (WS). Columbia County: Stayawhile Springs, 6 August 1927, *H. St. John & C. P. Smith* (WS). Walla Walla County: July 1896, *C. V. Piper* (WS, UO). Idaho. Bonner County: Priest River, 4 June 1925, *J. C. Witham* (WS). Idaho County: Lolo Trail, 17 July 1902, *C. V. Piper* (WS). Montana. Glacier National Park: Morning Eagle Falls, 11 August 1919, *P. G. Standley 17563* (US, GH); Glacier Basin, 5 August 1901, *F. K. Vreeland 1040* (GH, US, NY); near Iceberg Lake, 11 July 1919, *Standley 15451* (US, NY); 11 July 1914, *A. S. Hitchcock 11954* (US); 31 July 1917, *W. B. Dunkle* (UI). Lake County: Swan Lake, *M. J. Elrod* (UM); Flathead Lake, July 1908, *M. E. Jones* (UM). Glacier County: Kootenai Mountains, 11 August 1901, *L. M. Umbach* (PhA, US, NY); Midvale, 16 June 1903, *L. M. Umbach 48* (US, NY); near St. Mary's Lake, 24 June 1901, *Stuart Weller* (US); Flathead Pass, 29 June 1905, *J. W. Blankinship 475* (US). Missoula County: Missoula, 7 June 1897, *M. J. Elrod* (MS, UM), May 1907, *J. A. Hughes* (UM). Deer Lodge County: Anaconda, 5 June 1891, *S. A. Merritt* (UM), 1 June 1892, *F. D. Kelsey* (UC). Flathead County: near Granite Park Chalets, July 1919, *Standley 16246* (US); near Glacier Park Station, 6 July 1919, *Standley 15139* (US); near Columbia Falls, 24 July 1892, *R. S. Williams 135* (US); Glacier Park Station, 1920, *Mrs. O. Thompson* (US); MacDougal Peak, August 1901, *D. T. MacDougal 626* (US, NY), 31 July 1908, *B. T. Butler 978* (NY); Columbia Falls, 5 May 1893, *R. S. Williams* (NY, MS). California. Siskiyou County: Marble Mountain, June 1901, *H. P. Chandler 1619* (DH, UC, US, NY); Siskiyou Mountains, June 1879, *V. Rattan* (DH); Marble Mountain, 9 July 1910, *Butler 1715* (UC). Trinity County: Union Creek, July 1909, *H. M. Hall 8647* (UC); Trinity Summit, 1 July 1901, *Mrs. Manning 6* (US, UC). Humboldt County: South Fork Mountain, 9 June 1896, *Blasdale* (UC). British Columbia. Mt. Provost, Vancouver Island, 16 May 1910, *H. J. Muskeet* (PM); Mt. Ben-

son, Vancouver Island, 6 August 1887, *John Macoun 7* (GH), 8 June 1887 (NY); Cranbrook, 17 June 1915, *Garrett* (PM); Lytton Mountains, 14 July 1924, *W. B. Anderson* (PM); Creston, 2 May 1908, *J. R. Anderson* (WS); Chase, 29 April 1918, *J. R. Anderson* (WS); Crawford Bay, *Harrison* (WS); Enderley, 28 June 1907, *J. R. Anderson* (WS); near Glacier, 5 July 1896, *W. R. Dudley* (DH); Emerald Lake, 20 June 1904, *R. T. Shaw* (UWy, GH, PhA); Big Bend district, July 1931, *C. H. Shaw 1061* (GH, PhA, US, NY); near Glacier House, June 1896, *Clara E. Cummings* (GH); Asulkan Valley, 14 August 1904, *J. G. Jack* (GH); Rogers Pass, August 1890, *J. M. Macoun* (GH); Yoho Trail, 2 August 1903, *M. A. Barber 303* (GH); Asulkan Valley, 21 June 1906, *S. Brown 248* (GH, PhA, US, NY); near Field, 29 June 1906, *S. Brown 362* (GH, PhA, US); Illecillewaet River, 27 August 1904, *H. Peterson 570* (GH, PhA, US, NY); Selkirk Range, 20 August 1885, *John Macoun* (GH); Kootanie Lake, 10 July 1890, *John Macoun* (GH, US); Kicking Horse Lake, 22 July 1885, *John Macoun 5963* (GH); Cascade Summit, Glacier, August 1895, 1901, *Dr. C. Schaffer* (PhA); Selkirk Mountains, 31 July 1890, *John Macoun* (US, NY); Moose River, 20 July 1911, *N. Hollister 53a* (US); Great Northern Mountain, 3 August 1904, *E. W. Scheuber* (US); Burgess Pass, 1919, *Mary Walcott* (US); Chilliwack Valley, 14 July 1901, *John Macoun* (US, NY); Glacier, July 1897, *Zoe Palmer* (NY); between Kettle and Columbia Rivers, 26 May 1902, *J. M. Macoun* (NY); Chilliwack Valley, 14 June 1906, *W. Spreadbrough* (NY); Revelstoke, 14 May 1902, (NY); Tulamee River, July 1900, *J. F. Kemp* (NY). ALBERTA. Mt. Massey, Fortress Pass, 7 July 1927, *A. J. Ostheimer 3rd. 72* (GH); near Beaver River, June 1928, *A. H. Brinkman 3004* (NY).

In the publication of the new name, Dr. St. John has set forth fully and convincingly his reasons for discarding the name *parviflorum.*

Following is a copy of Watson's original publication of his variety *parviflorum;* "Scape usually low; flowers smaller, the segments 12 to 15 lines long.—*E. Nuttallianum,* Regel, Gartenfl. t. 695, not R. & S.; *E. grandiflorum,* Murray, Gard. Chron. 1874, fig. 173. In the mountains from Colorado and northern Utah to British America, in the Blue Mountains of Oregon, and in the Cascade Mountains of Washington and British Columbia; the more common form."

It will be noted that in the brief description there is no reference to anther-color, size of plant and flower alone being considered. A complete field survey of the whole range of the widely distributed *E. grandiflorum* complex furnishes convincing proof that there is no ground for separation on this basis. In an examination of all of the material in the Gray Herbarium where Watson worked, and where all of his *Erythronium* types are held, I found no evidence to indicate that he had any particu-

lar collection which might reasonably be considered the type; and his inclusion of the whole range of the three forms of the species in that of his variety only lends weight to the conclusion that anther-color had nothing to do with the question under consideration.

As to the two citations quoted above: the first, according to St. John, is a good colored plate showing a plant with red anthers, which "is clearly identical with the earlier *E. grandiflorum* Pursh, and hence different from the white-anthered plant so long called var. *parviflorum*." The second cut "is not colored, and the accompanying discussion makes no mention of the color of the anthers, but, in absence of proof, there is no reason to assume that it is different from *E. Nuttallianum* Regel or *E. grandiflorum* Pursh. The plant came from near Salt Lake, Utah." During the season of 1933, I collected *Erythronium* in the region about Salt Lake. From these field investigations, information furnished me by the botanists of the region, and examinations of many collections in various herbaria, including that of the University of Utah, in Salt Lake City, I am convinced that *E. grandiflorum* Pursh is the only form of *Erythronium* to be found in the vicinity of Salt Lake. The only other occurring within the borders of the state of Utah, seems to be the yellow-anthered form, *Erythronium grandiflorum* subsp. *chrysandrum* Applegate. This I found in abundance on Mt. Timpanogos near Provo.

Further discussion of the *Erythronium grandiflorum* group will be found under *E. grandiflorum* subsp. *chrysandrum* Applegate, which explains the unique nomenclatorial position of the name *parviflorum* as used in the specific category by Goodding.

5b. Erythronium grandiflorum subsp. chrysandrum Applegate, Contr. Dudley Herb. 1: 190. 1933. *Erythronium parviflorum* Goodding, Bot. Gaz. 33: 67. 1902, as to description and type. Not *E. grandiflorum* var. *parviflorum* S. Wats. which equals *E. grandiflorum* Pursh.

Anthers golden-yellow; otherwise the same as the typical red-anthered *E. grandiflorum* Pursh.

In the Wasatch Mountains of Utah and in the Rocky Mountains of Colorado and of southern Wyoming, the style is rather commonly stout and strongly clavate, and the stigma lobes often quite short and erect or spreading instead of recurved, and rarely with a very shortly lobed to merely a toothed stigma. This is also true of *E. grandiflorum* Pursh in the mountains of northern Utah where Watson collected it in 1869. His description (Bot. King Exp. 348. 1871) reads: "stigma capitate or more or less 3-cleft and spreading. . . ."

Type in the Dudley Herbarium, 207818, collected in a field cleared from yellow pine woods, in the vicinity of Winchester, Nez Perces County, Idaho, 3 May 1931, *Applegate 6760*.

Other collections were made in Idaho the same year by myself as follows: near Athol, Bonner County, *6706a,* and five miles east of Rathdrum, Kootenai County, *6707a,* 28 April; near Culdesac, Nez Perces County, *6721a,* 1 May; near and west of Kamiah in Lewis County, *6755a* and between Craigmont and Nez Perces, Lewis County, *6758a,* 3 May. In 1933, I collected the following in Utah: west slope of Mt. Timpanogos, near Provo, Utah County, *8427* and *8428,* 12 June, and north slope, *8446,* 13 June.

Specimens examined. WYOMING. Albany County: Telephone Mines, 30 July 1900, *A. Nelson 7833* (UWy, UC, OS, DH, UO, UCo, NY, GH, US, UWy, the last the type of *E. parviflorum* Goodding); University Camp, Medicine Bow Mountains, 29 June 1925, *A. Nelson 10558* (UWy, UC); Medicine Bow Mountains, May–August 1929, *Nelson 11038* (UWy, UC, NY) and August 1909, *Nelson 9238* (UW, DH, US, GH, NY); La Plata Mines, 22 August 1895, *Nelson 1796* (US, GH, NY); Medicine Bow Mountains, June 1902, *J. F. Kemp* (NY). Johnson County: Big Horn Mountains, 1 May 1905, *Vie Willits* (UWy); Trabbing Creek, 6 May 1909, *Vie Willits* (UWy). Carbon County: Hayden Forest, 7 July 1915, *W. W. Eggleston 11294* (US); Encampment, 7 July 1911, *Merritt Cary 652* (US); Battle, Continental Divide, 20 June 1901, *Frank Tweedy 4457* (US, NY); Douglas Creek, 12 June 1896, *W. O. Owens* (UWy). COLORADO. Larimer County: Estes Park, 17 June 1908, *W. S. Cooper 122* (UWy); Chambers Lake, 30 June 1921, *Caroline M. Preston* (CS); Cameron Pass, *New York Botanical Garden 2461* (UWy, CS, UM, US, WS, NY), 24 July 1894, *C. S. Crandall 480* (US), 14 July 1896, *C. F. Baker* (NY); Mt. Cameron, 6 July 1908, *G. F. Osterhout 3763* (DH); White Mountains, 9 August 1873, *J. M. Coulter* (PhA); Buffalo Pass, (UCo). Boulder County: Long's Peak, 5 August 1886, *G. W. Letterman* (US, PhA); near Long's Peak, 1868, *Vasey 555* (US, GH); Ward, 24 June 1923, *Hazel M. Schmoll* (UCo); Arapahoe Peak, 29 July 1918, *J. W. Clokey 3145* (NY). Jackson County: mountains west of North Park, 22 August 1899, *G. F. Osterhout* (NY); North Park, 7 July 1894, *C. S. Crandall* (NY); Rabbit Ears, 14 July 1903, *L. N. Goodding 1538* (UWy, UCo, DH, UC, US, PhA, GH, NY); Rabbit Ears Pass, 2 August 1917, *Johnson & Hedgcock 767* (UWy); Buffalo Creek, 29 June 1901 (UU), Buffalo Pass, 13 August 1898, *Shear & Bessey 3864* (NY). Gunnison County: near Mt. Carbon, 9 June 1910 *W. W. Eggleston 5710* (US), 6 June 1910, *Eggleston 5647* (US), 26 May 1910, *Tidestrom 3430* (US). North Park near line between Routt and Jackson counties, 22 August 1899, *G. E. Osterhout* (UWy, cotype *E. parviflorum* Goodding). Garfield County: Battlement National Forest, 30 July 1912, *J. R. Searge* (US). Montrose County: Uncompahgre Divide, 6 June 1912, *E. B. Payson 44* (UWy); Tabequache Basin, 3 June 1914, *Payson 378* (GH, DH, UWy, UCo). Mesa County: Grand Mesa,

23 June 1901, *C. F. Baker 224* (UWy, UC, US, GH, NY). La Plata County: Bear Creek Divide, La Plata Mountains, 29 June 1928, *Baker, Earle & Tracy 213* (NY, US), and 15 July (US); Durango, July, *L. M. & N. T. Schedin* (UWy); Needle Mountains, 14 July 1901, *W. Cross 47*. Delta County: source of Leroux River, 21 July 1892, *J. H. Cowen* (CS); High Mountains, 21 July 1892, *Cowen* (US). Pitkin County: Ohio Pass, Elk Mountains, 1881, *Brandegee* (UC); near line between Montezuma and La Plata counties: Crested Butte, La Plata Mountains, June 1890, *Alice Eastwood* (UCo). Utah. San Pete County: Manti Canyon, 6 July 1899 (UU), 1 June 1928, *V. C. Fish* (UU); Manti National Forest, 20 July 1908, *W. C. Clos* (US); Ephriam Canyon, 14 August 1907, *Tidestrom 228* (US). Summit County: Bear River, Uinta Mountains, 7 July 1926, *E. B. & L. B. Payson 4898* (PhA, GH, US, UWy, UC, DH). Utah County: near Provo, Wasatch Mountains, 16 June 1902, *Goodding 1131* (US, NY, DH, UC, UWy, GH); Mt. Majestic, 28 June 1905, *Rydberg & Carlton 6367* (NY, US); Provo, 10 July 1924, *M. E. Jones 5589* (US). Idaho. Nez Perces County: Winchester, 15 May 1927, *F. W. Gail* (UI).

Distribution: in Idaho, as far as I know, to be found only in two rather widely separated localities. On the high tableland south of the Clearwater River in the vicinity of Winchester, the type locality, the species occurs in a very restricted area, in abundance among a scattered growth of yellow pine, open pasture lands, and in cultivated fields. Here was found only an occasional individual plant with red anthers by which the yellow-anthered form is almost entirely replaced in the surrounding region. No white-anthered plants were found anywhere in the Clearwater region. More than one hundred miles to the northward there is an occasional sporadic occurrence of the yellow-anthered form in the timbered flat country lying between Pend Oreille and Coeur d' Alene lakes, where there is an abundant intrusion, from the east, of the white-anthered ones into a large area of red-anthered plants. At the point of contact were found also intermingled individuals with pink or purplish anthers, teratological forms and other evidence of hybridization. In Utah the yellow-anthered form seems to be confined to the Uinta Mountains and to the southerly parts of the Wasatch Mountains. In the Rocky Mountain region of Wyoming and Colorado it is the common form. Collections have been made in the La Plata Mountains in southwestern Colorado, and reported from La Plata County near where these mountains branch off from the main continental divide and continue southeasterly as the San Juan Mountains across the border into New Mexico. Although *Erythronium* has never been reported from that state, I suspect that the genus will sometime be found there among the high peaks of the San Juan range. In western Colorado *E. grandi-*

florum subsp. *chrysandrum* seems to be common on the Grand Mesa and in the Umcompahgre Mountains.

Gooddings's plant, as to designated type and essentially as to description, is the same yellow-anthered form, based upon collections from "Wyoming, Telephone Mines, 1900, Aven Nelson 7833" (Type), and "Colorado, summit of mountains west of North Park, 1899, G. E. Osterhout" (cotype). In his remarks accompanying the original publication, Goodding says: "This species differs from *E. grandiflorum* principally in being much smaller, in its smaller bright yellow flowers"; adding that "the description of *E. grandiflorum parviflorum* Wats. is very indefinite and incomplete, but undoubtedly refers to the above form, which is well worthy of specific rank."

In June, 1933, at the Rocky Mountain Herbarium of the University of Wyoming, Laramie, I examined all of the type material and many other specimens from the type region, and interviewed various botanists familiar with the plant. More recently I have corresponded with other botanists, who later in the season than my visit, made special field investigations for me, having in mind, particularly, anther-color. All of which furnished convincing evidence that there is only the yellow-anthered form throughout the entire region. At the time of my visit, it was too early in the season for flowering specimens of *Erythronium.*

It is amply apparent that Goodding, intending to raise Watson's varietal name to specific rank, and having at hand the yellow-anthered form, under the mistaken belief that it was the same, calls attention to Watson's incomplete description which he undertakes to amplify. At the same time, he designates a definite type which proves to be the common yellow-anthered Rocky Mountain form. So, notwithstanding the fact that he had in mind Watson's plant, which turns out to be the typical red-anthered form, he unintentionally published a new species based upon the yellow-anthered plant. To add to the complexity of the situation, St. John, in discarding Watson's varietal name, relegated Goodding's specific use of it to the same position on the ground that it was based entirely upon Watson's variety, under the misapprehension that it applied to the same white-anthered form to which he gave the new name *E. grandiflorum* var. *pallidum,* in allusion to the color of the anthers. In this connection, it is interesting to note that at the time of publication of the names of these two segregates (var. *pallidum* and subsp. *chrysandrum*) neither author realized that the representatives of *E. grandiflorum* in the Rocky Mountains of Colorado and of southern Wyoming had yellow anthers; nor does it appear likely that Goodding, at the time he named his plant, understood that the form west of the Cascade Mountains was the white-anthered one. And so the whole story resolves itself into a complicated case of mistaken identity.

6. Erythronium idahoense St. John & Jones, Research Stud. St. Col. Wash. 1: 91. 1929. *Erythronium grandiflorum* var. *albiflorum* Purdy, Flora and Sylva 250–256. 1904. *Erythronium grandiflorum* subsp. *candidum* Piper, Fl. Southeast Wash. 61. 1914.

Corm 5–7 cm. long, about 1 cm. thick; leaves commonly oblanceolate, acute (the larger sometimes obtuse) attenuate to a long slender narrowly winged petiole, frequently pink at base, 10–15 cm. long, 1–2.5 cm. broad; scape 15–20 cm. high, usually pink below, seldom bearing more than one flower; buds greenish, the young flowers greenish-white, becoming creamy to pure white with solid greenish-yellow center, the segments lanceolate, acuminate, 3.5–4.5 cm. long (rarely longer), 10–12 mm. broad, the inner set often angled at the broadest part and abruptly narrowed at the base, the median appendages well developed, flattish, elongated, the lateral ones represented by the revolute edges of the rather small auricles; filaments filiform, of nearly uniform width, the two sets regular, the inner usually at least 2 mm. longer than the outer; anthers white, the young ones commonly about 15 mm. long; style clavate, very slender below, more or less kinked, and often somewhat declined at base; stigma moderately cleft, the lobes stoutish, not strongly recurved, sometimes slightly unequal in length; capsule about 5 cm. long, 15 mm. thick, the angled sides oblanceolate in outline, apex obtuse.

In 1931 I collected specimens in Idaho as follows: Kootenai County, near Ford, 28 April, *6711;* near Worley (type locality), 28 April, *6713;* Benewah County, Plummer, 29 April, *6714.*

While at Pullman, Washington, April, 1931, I examined all of the specimens in the herbarium of the Washington State College cited in the original publication of the species.

Type: "Cut-over pine woodland, Worley, Kootenai County, Idaho, 21 March, 1926, *St. John, English, Jones, Ransom & Ridout, 3719* (type in herb. State College of Washington." The type of Piper's subsp. *candidum* (in the U. S. National Herbarium) was collected on Steptoe Butte, Whitman County, Washington, 6 April 1906, by J. W. Hungate. Mr. Purdy writes me that his material of *E. grandiflorum* var. *albiflorum* Purdy came from Fairfield, Spokane County, Washington, which is about twenty-five miles southwest of the type locality of the species.

Distribution: in the yellow pine region along the eastern border of Washington, in Pend Oreille and Whitman counties, and the western border of Idaho, in Kootenai and Benewah counties. Extremely abundant in the southwest corner of Kootenai and the northwest corner of Benewah County (the type region), in low, rolling hills with intervening small valleys. In passing southward from Coeur d' Alene Lake, the whole country is yellow with *E. grandiflorum* Pursh to a point just south of Ford where that species abruptly ends at the edge of an east and west road. On the opposite side of the road *E. idahoense* appears as suddenly and in as great abundance, everywhere—in the woods,

in the open pastures and in wheat and alfalfa fields, extending southward without interruption for perhaps fifteen miles to the edge of the treeless plains in the vicinity of Tekoa in the northeast corner of Whitman County, Washington. Even along the point of contact there is practically no intermingling of the two species of the region.

In the original description, mention is made of the "dimorphism" of the stamens, in which it is stated that there are many plants with six long stamens, many with six short stamens and others with three long and three short ones. This seems to be based upon a misunderstanding of the behavior of the anthers in their various stages of development. In all of the species of the genus with which I am familiar, in the bud and up to about the time of anthesis, or sometimes a little later, the anthers are all long and of equal length; later the three outer ones dehisce and shrink to about half their original length, at which time there are, obviously, three long and three short anthers; finally the inner set goes through the same process, when, of course, there are six short anthers. The original length can usually be restored by soaking. Also the filaments are described as being "usually of equal length, but sometimes three distinctly longer." Normally in the genus they are in two sets, of equal length in each set, the outer being the shorter, the only exception among our western species being *E. grandiflorum* var. *pallidum* St. John. In the type region of *E. idahoense,* I made careful measurements of many sets of filaments, and found them quite constantly regular, the difference in length of the two sets being rather uniformly 2 mm.

The authors in describing the species, state that it is more similar to *E. montanum* S. Wats. than it is to *E. grandiflorum* Pursh. The resemblance I am inclined to think, is more superficial than otherwise. No point of similarity is mentioned other than color of perianth, and even this is only partly true. On the other hand, attention is called to the striking difference in leaf form, and in geographic and zonal distribution. *E. grandiflorum* and *E. idahoense* are practically identical morphologically and in general aspect and habit. The only marked difference is in color of flower. This, however, is very constant as color differences usually are in the genus, and the two species while sometimes growing in more or less close proximity, are apparently always found in separate colonies. While *E. idahoense* more commonly has an oblanceolate leaf, and that of *E. grandiflorum* is more often lanceolate, the difference is by no means constant. *E. montanum* is truly subalpine, with a leaf characteristically different from all of our other western forms, and with the color areas of the perianth segments sharply defined, in strong contrast to the condition in all of the members of the *E. grandiflorum* group.

It is interesting to record here that Charles A. Geyer, then a most courageous and remarkable young German botanist, collected in the Coeur d' Alene region and southward to the Clear-

water country during the early part of the season of 1844, having with great difficulty and danger made his way alone across the Rocky Mountains during the previous winter. In the Herbarium at Kew is a well preserved set of his number *601*, a collection to which he gave the manuscript name *E. pallidum*. Accompanying this is the following note: "Abundant in the Coeur d' Alene Mountains on grassy slopes of the hills close to the valley, rare southward. The adjoining Spokane country abounds with a more beautiful bright golden-yellow species with brown anthers, much longer." (The last, of course, is *E. grandiflorum* Pursh.) Although referred to that species by Hooker in his list of Geyer's plants, it would seem by inference to be *E. idahoense*, the species common in the region referred to by Geyer, although it might be *E. grandiflorum* var. *pallidum* St. John. This, however, does not seem likely, in view of the fact that all of the anther-color forms of that species have the same yellow perianth color. Geyer's reference to the "golden-yellow" of the Spokane plant in contrast to his *"601"* with his manuscript name *"pallidum,"* would seem to indicate the white flowered plant. Recently I examined specimens of this collection (*Geyer 601*) which were distributed to the Gray Herbarium of Harvard University. I am indebted to Mrs. R. S. Ferris of the Dudley Herbarium of Stanford University for an excellent photograph of specimens of this collection which she secured for me at Kew Herbarium. While it is difficult to determine with certainty the various forms of this group, from herbarium specimens, I should say that Geyer's plant is the earliest collection of *E. idahoense* St. John & Jones.

The beginning of Geyer's narrative will be found in the London Journal of Botany (vol. 4: 479. 1845). The catalogue of his plants appears later in the same publication and is concluded in Hooker's Journal of Botany (vol. 3: 287. 1851).

Specimens examined. Idaho. Kootenai County: Worley, 21 March 1926, *St. John, English, Jones, Ransom & Ridout 3719* (WS, type), 25 April 1926 (fr.), *St. John, Gessell, Jones, Ridout & Woods 4255* (WS); near Worley, 17 April 1923, *Nettie M. Cook* (WS); Coeur d' Alene, 24 May 1923, *Nettie M. Cook* (WS). Benewah County: Lovell, 21 March 1926, *St. John, English, Jones, Ransom & Ridout 3730* (WS). Latah County: 5 miles east of Harvard, 18 April 1926, *Georgina Burke*, (WS). Washington. Pend Oreille County: Tiger, 29 April 1925, *E. E. Hupp* (WS); Molybdenite Mountain, 16 May 1925, *St. John, Pickett, Davidson & Warren 3741* (WS), 5 June 1926, *W. F. Hagemyer* (WS). Spokane County: Waverly, 19 April 1928, *J. H. Snyder* (WS, PhA, GH). Whitman County: Steptoe Butte, 6 April 1906, *J. W. Hungate* (WS, isotype and US, type of *E. grandiflorum candidum* Piper). Shoshone County: "Coeur d' Alene Mountains," 1844, *Geyer 601* (GH).

Erythronium idahoense forma *tricolor* St. John, Research Stud. St. Coll. Wash. 1: 95. 1929: in my field investigations covering all known western forms of *Erythronium*, I have found many con-

tacts between various species. Usually there are unmistakable indications of hybridization. These consist of color changes and various malformations of flower parts. Hence I am inclined to believe that this form is the result of a cross between *E. idahoense* St. John & Jones and *E. grandiflorum* Pursh. Dr. St. John himself suggests this possibility. I examined the type at the Washington State College, Pullman, where it is deposited.

7. Erythronium montanum S. Wats. Proc. Am. Acad. 26: 130. 1891.

Corm rather slender, about 3.5 cm. long, 4–5 mm. thick, the button-like scars of old corms retained in a crowded chain for a number of years, even 10 to 15; leaves 10–15 cm. long, 1–2 cm. broad, often with little difference in width of the two, commonly broad- to ovate-lanceolate (rarely ovate, subcordate), acute, usually abruptly narrowed to a slender, nearly wingless petiole, this frequently almost as long as the blade; scape 15–30 cm. high, or even higher sometimes, bearing frequently only a single flower, but often several; the perianth segments pure white except for the lower part of the narrow base of pure plain yellow, the color areas well defined, the outer segments sometimes streaked with pink without, delicate in texture, lanceolate to rather broadly lanceolate, acuminate, sharply acute, 25–40 mm. long, 7–10 mm. broad (frequently larger); the median pair of appendages well devolped inflated, closed sacs, the auricles folded into a separate ridge; filaments very slender and of nearly or quite uniform thickness; anthers golden-yellow; style slender, scarcely enlarged above; stigma lobes only moderately long and somewhat tardily recurving; capsule 2.5–3 cm. long, about 12 mm. thick, long obovate with cuneate base and retuse apex.

This species has the most distinctive leaf of any of our western forms. With its usually broad blade, abruptly narrowed and sometimes subcordate base, long slender petiole and evenly acute apex, it is suggestive of that of the old world type.

Founded on the following: "On the high mountains of Oregon and Washington (Mt. Hood, Mt. Adams, etc.); *Mrs. P. G. Barrett, Howell and Suksdorf;* in flower from July to September." Type collected by Thomas Howell 601 on the north slope of Mt. Hood, 1 August 1886, the exact station probably at or in the vicinity of Elk Cove, along the trail west of Cloud Cap Inn, at about 5500 feet altitude.

Distribution: Canadian and Hudsonian zones, on Mount Hood and vicinity in the northern Cascade Mountains of Oregon, northward on the high peaks of the Cascade and Olympic mountains of Washington, and the higher parts of the mountains of Vancouver Island, British Columbia. The center of greatest abundance is on Mt. Rainier, where in Paradise Valley and similar localities, very extensive colonies are found. On Mt. Hood, smaller but most attractive colonies occur among the snow-

banks near the foot of glaciers, in openings in the forests of fir, hemlock and white barked pine; and often associated with *E. grandiflorum* var. *pallidum* St. John. No hybrids between these two species have been noted.

Specimens collected. WASHINGTON. Pierce County: Paradise Valley, Mt. Rainier, 9 August 1926, *4886, 4890, 4891*. OREGON. Hood River County: Elk Cove trail, north slope of Mt. Hood, 14 August 1932, *8250;* Elk Cove, 15 August 1932, *8259, 8274*.

Specimens examined. OREGON. Hood River County: Mt. Hood, 5 August 1926, *Carl English Jr.* (WS); north side of Mt. Hood, 1 August 1886, *Thos. Howell 601* (UO, NY, GH, type); 22 August 1895, *Howell 1523* (UC, UO, NY, US); 4 August 1927, *J. W. Thompson 3386* (DH); 10 August 1893, *Howell* (UC); Lost Lake, Mt. Hood, 26 June 1921, *Peck 9889* (DH, NY); Mt. Hood, 29 July 1886, *Howell 1031* (US); 1882, *Mrs. P. G. Barrett 36* (GH, cotype). Multnomah County: Larch Mountain, 19 June 1927, *J. W. Thompson 2717* (DH, GH). WASHINGTON. Pierce County: Mt. Rainier, 23 July 1894, *O. D. Allen 82* (UC, WS, DH); 20 August 1892, *Allen 12* (GH); Round's Pass, Mt. Rainier, 29 June 1927, *F. A. Warren 642* (WS); Sluiskan Falls, Mt. Rainier, 22 June 1926, *Warren* (WS); Mt. Rainier, *J. B. Tarleton 81* (UC), August 1928, *H. E. and S. T. Parks 21055* (UC, GH); 1882, *Brandegee* (UC); *L. R. Abrams 9011* (DH, NY); 25 July 1905, *Dudley* (DH); 29 July 1905, *Sheldon 13216* (DH); 1894, *Rev. Thompson* (DH); 4 July 1926, *Miss Dobie* (DH); 1 August 1895, *Piper 193* (WS); 1 August 1896, *J. B. Fleet 256* (WS); 1899, *Fleet* (US); 23 August 1923, *St. John 3744* (WS); July 1917, *Mrs. S. E. Kelley* (CA); 4 August 1914, *Alice Eastwood* (CA); July 1913, *Julia McDonald* (CA); July 1924, *M. S. Baker* (CA); August 1895, *Bailey Willis* (US); August 1895, *Piper 2118* (US, GH); 11 August 1928, *Heller 14767* (NY, US); 22 July 1930, *Lyman Benson 2301* (NY); July 1905, *M. W. Lyon Jr. 126* (US); 12 August 1909, *A. S. Foster 1083* (PhA); August 1897, *C. Hart Merriam* (US); 17 July 1907, *H. C. Cowles 691* (GH); Goat Mountain, Mt. Rainier, 26 July 1894, *Allen 83* (NY, US, GH). Skamania County: Mt. Adams, 25 July 1884, *Suksdorf* (UC, US, GH, cotype); near Mt. Adams, 3 August 1892, *Henderson* (WS); Mt. Adams, 11 August 1894, *F. E. Lloyd* (NY); Mt. St. Helens, 20 July 1898, *Coville 830* (US). Clallam County: Olympic Mountains, June 1900, *Elmer 2496* (DH, UO, NY, US); Sol Duc, 25 August 1921, *St. John 3742,* (WS); Bagachiel Peak, *I. C. Otis 1339* (WS, CA); Elwha River, 28 August 1921, *St. John 3743* (WS); Sol Duc, August 1912, *C. F. Newcomb* (PM); Olympic Mountains, 6 August 1928, *Mr. & Mrs. Leach* (UO); August 1895, *Piper 2220* (WS, GH). Jefferson County: Olympic Mountains, 13 July 1895, *Henderson 2038* (GH). Grays Harbor County: Mt. Baldy, 8 July 1902, *H. S. Conard 284* (NY, US, GH); 25 July 1897, *F. H. Lamb 1359* (NY). BRITISH COLUMBIA. Vancouver Island: Mount Washington, 13 July 1928, *Mrs. Mundy* (PM).

8. Erythronium Howellii S. Wats. Proc. Am. Acad. 22: 480. 1887.

Inner perianth segment bases narrow and entirely destitute of any kind of appendages, that is, naked; otherwise apparently identical with *E. citrinum* S. Wats. which occupies the territory immediately to the north and west.

For a number of seasons I have made field examinations of these two forms, covering practically their entire range in considerable detail, without being able to find any other distinguishing characters. In a search for contacts between the two, I found a colony on the west fork of the Illinois River west of Waldo, the type locality of *E. Howellii,* in which a considerable proportion of the plants had purplish anthers, suggesting hybridization. Upon closer examination of many plants, I found both forms intermingled, together with intermediate forms with appendages in various stages of development.

Concerning the processes on the perianth segments, it would seem that their value as specific diagnostic characters does not necessarily depend upon their size and conspicuousness. However trivial and inconvenient they may appear at first sight, they are at least definite and constant within the various species having them.

Type in the Gray Herbarium of Harvard University, collected at "Waldo, Josephine County, April 24, 1887, Thomas Howell 658." Named for the veteran Oregon botanist, Thomas Howell, author of the "Flora of Northwest America."

Distribution: the south end of the valley of the Illinois River, southern Josephine County, Oregon, for the most part the region lying within the east and the west forks of the Illinois River, southward into the lower elevations of the Siskiyou Mountains; Transition Zone. Also reported from Del Norte and Siskiyou counties, California, but thus far I have found only *E. citrinum* S. Wats. in all of the localities mentioned in these two counties. All the specimens examined from them labeled *E. Howellii* have proved to be of that species. The species is also listed in various publications as occurring on Vancouver Island. This seems highly improbable. In my field work there, and investigations at the Provincial Museum at Victoria, and at the University of British Columbia, I could find nothing to confirm the reports.

Specimens collected. Oregon. Josephine County: Waldo, 9 April 1925, *4178;* near Waldo, 10 April 1925, *4181;* near and south of Waldo, 10 April 1925, *4182;* 3 miles north of Waldo, 10 April 1925, *4188;* 6 miles north of Waldo, 10 April 1925, *4190;* Waldo, 20 April 1932, *7071;* Waldo, 7 April 1933.

Specimens examined. Oregon. Josephine County: Waldo, 24 April 1887, *Thomas Howell 658* (GH, type); April 1892, *Howell 1280* (UC); April 1925, *Henderson* (CA); 16 March 1926, *Henderson 5788* (DH, CA); near Waldo, 25 April 1887, *Howell* (UC, US); Takilma, 21 April 1929, *Doris Kildale 7410* (DH);

near Waldo, 6 May 1923, *Henderson* (PhA); Waldo, April 1923, *M. S. Baker 7416*.

9. Erythronium citrinum S. Wats. Proc. Am. Acad. 22: 480. 1887.

Corm slender, about 5–7 cm. long, 1–1.5 cm. thick; leaves 10–15 cm. long, 1.5–3.5 cm. broad, lanceolate to oblong-lanceolate, acute to acutish, occasionally obtuse, especially the larger; petiole from short and broadly winged to long and slender; scapes 10–25 cm. high, often bearing several flowers, either approximate or distant, sometimes the stem branching from a common point above the leaves; perianth segments white to creamy-white with light lemon-yellow base, either plain or irregularly splotched and broken by a paler transverse band, greenish-yellow with sometimes a tinge of pink without, 25–40 mm. long, 6–8 mm. broad; appendages moderately well developed, the median pair globular, inflated sacs, the auricles with margins turned back to form an open cup-like sac, resembling the closed ones but smaller; filaments slender and attenuate; anthers white, blunt; style usually rather stout and clavate, commonly 6–8 mm. long; stigma shortly to very obscurely lobed; capsule long-obovoid, rounded or abruptly narrowed at apex.

Distribution: common in chaparral and open oak and yellow pine woods, Transition Zone. Slate Creek of lower Applegate River watershed, southward through the Deer Creek hills and the Illinois River Valley to the south fork of the Illinois, thence along the valley of the west fork into the Siskiyou Mountains, Josephine County, Oregon; along Smith River, Del Norte County, and the Klamath and Scott River regions into Quartz Valley, Siskiyou County, California. Replaced on the southerly slope of the Trinity Mountains by *E. californicum* Purdy.

Type in the Gray Herbarium, collected "In the Deer Creek Mountains, Josephine County, Oregon, April 24, 1887, Thomas Howell 657."

Specimens collected. Oregon. Josephine County: Butcherknife Creek, 9 April 1925, *4175;* Kerby, 10 April 1925, *4194;* Deer Creek, 11 April 1925, *4198;* near Kerby, 11 April 1925, *4196;* Eight Dollar Mountain, 11 April 1925, *4197;* Hayes Hill grade, 11 April 1925, *4199, 4200;* Welter Mill, Butcherknife Creek, 11 April 1925, *4215;* Eight Dollar Mountain, 14 June 1929, *5714;* Hayes Hill, 4 April 1931, *6641;* north of Kerby, 4 April 1931, *6644;* near Selma, 4 April 1931, *6645;* Hayes Hill, 20 April 1932, *7072;* 7 April 1933, *8309;* Slate Creek, *8313*. California. Del Norte County: Adams Station, Smith River, 29 March 1931, *6628*. Siskiyou County: Quartz Valley, near Ft. Jones, 15 April 1932, *7059;* Klamath River opposite mouth of Doggett Creek, 16 April 1932, *7061;* near Hamburg, Klamath River, 16 April 1932, *7062*.

Specimens examined. OREGON. Josephine County: Eight Dollar Mountain, 11 March (fl.), 16 June (fr.) 1926, *Henderson 5786* (DH, UC, CA, UO); near Selma, 13 April 1927, *J. W. Thompson 2283* (DH), 29 April 1928, *Mrs. Gale 25* (DH, PhA); west fork Illinois River, 21 April 1929, *Doris Kildale 7391* (DH); Mendenhall Creek, 20 April 1929, *Kildale 7326* (DH); Hayes Hill, 22 March 1925, *Sweetser, Henderson & Savage* (UO); Slate Creek, 5 May 1923, *Sweetser* (UC); Kerby, 3 May 1923, *Sweetser* (UC); near Deer Creek, 26 April 1887, *Thos. Howell* (UC, US); Anderson's, April 1892, *Howell 1281* (UC, US); Loves Station, 19 April 1905, *M. S. Baker* (UC); Deer Creek Mountains, 24 April 1887, *Thomas Howell 657* (GH, type); Mt. Grayback, 15 June 1904, *Piper 6232* (GH, US); Hayes Hill, 5 May 1923, *Henderson* (PhA); Kerby, 22 March 1927, *M. E. Peck 14737* (PhA). CALIFORNIA. Siskiyou County: Quartz Valley, 24 April 1909, *Geo. D. Butler 661* (DH, UC). Del Norte County: Adams Station, 29 March 1928, *Alice Eastwood 15056* (UC, CA, US); near Patrick Creek, 22 April 1907, *Eastwood 71* (US).

10. ERYTHRONIUM HENDERSONII S. Wats. Proc. Am. Acad. 22: 479. 1887.

Corm 4–6 cm. long, 1–1.5 cm. thick, rarely multiplying by sessile offsets; leaves 10–20 cm. long, 1.5–5 cm. broad, lanceolate to broadly lanceolate, acute (the larger often obtuse), petiole long and slender or shorter and broadly winged; scape purplish, sometimes branching from a common point above the leaves, or more or less distantly, rarely as many as 10–12 branches closely approximate; perianth segments from light to dark lavender, the bases very dark purple within, surrounded by a white or yellowish zone, the upper edge sharply toothed, lanceolate, acuminate to broadly lanceolate, bluntish and cucullate, 25–40 mm. long, 6–8 mm. broad, the appendages conspicuous, closed, globularly inflated sacs, the median pair larger and more inflated, the lateral ones covering the auricles; filaments purple, slender and attenuate; anthers buff or straw-colored with brown center line; style purple, often little longer than the purple ovary, stout, strongly clavate; stigma practically entire or obscurely lobed or toothed; capsule obovoid to ellipsoid, 3–4 cm. long, 2 cm. thick.

Type in Gray Herbarium of Harvard University, collected by L. F. Henderson, near Ashland, Jackson County, Oregon, April, 1887. Cotype collected by Thomas Howell, Grants Pass, Josephine County, Oregon, the same month.

This is the first *Erythronium* with which I became acquainted, the type locality being my birthplace and early home. During the early period of my interest in these beautiful plants, this species, as well as most of the others of southwestern Oregon and northwestern California, were as yet unnamed. It is a matter of satisfaction to note that the species here discussed

fittingly bears the name of my friend Professor L. F. Henderson, now curator of the herbarium of the university of my native state.

Distribution: throughout the Transition Zone in the Rogue River hills from Wolf Creek, Josephine County, near the southern boundary of Douglas County, Oregon, southward through the Rogue River Valley, Josephine and Jackson counties, across the Siskiyou Mountain pass in the vicinity of Pilot Rock, into the valley of the Klamath River, California, southward to the south fork of Salmon River, Scott Mountains, southern Siskiyou County; eastward from Rogue River Valley into the yellow pine region of the Cascade Mountains to Jenny Creek, a tributary of the Klamath River, nearly to the western boundary of Klamath County, Oregon; and westward throughout the greater part of the valley of the Applegate River, Jackson and Josephine counties, Oregon. The altitudinal range is from about 1500 feet to 5000 feet on exposed slopes.

Erythronium Hendersonii is very similar morphologically to *E. Howellii* S. Wats. and *E. citrinum* S. Wats., but strikingly different in color, and usually having a shorter style with a more constantly entire stigma.

At all of the regions of contact with the following species well marked hybrids were found: *E. oregonum* Applegate and *E. citrinum* S. Wats. on Slate Creek, eastern Josephine County; *E. oregonum* subsp. *leucandrum* Applegate, Evans Creek, Jackson County; *E. klamathense* Applegate, Keene Creek Prairie, Cascade Mountains, Jackson County. The species was found also on the Klamath River near Hamburg, Siskiyou County, California, with *E. citrinum* S. Wats. Here no hybrids were noted.

In cultivation, the tendency to reproduce by multiplication of corms from the base of the old ones is greatly stimulated by irrigation, a single corm gradually producing by sessile offsets a clump or bed, instead of becoming dormant as the ground dries under natural conditions. This tendency has been observed in a number of other species, and is perhaps true, to a greater or less degree, in the genus. *Erythronium tuolumnense* Applegate is the only species habitually to reproduce in nature in this manner; while *E. helenae* Applegate does so less freely under the most favorable soil and moisture conditions, and to a remarkable degree in cultivation.

Specimens collected. OREGON. Jackson County: Carter Creek, Siskiyou Mountains, 30 May 1895, *710a;* Sampson Creek, Cascade Mountains, 1 June 1895, *710;* Siskiyou Mountains south of Ashland, 20 May 1898, *2237;* Jenny Creek, 11 May 1924, *4048;* Keene Creek, 11 May 1924, *4081;* Keene Creek ridge, 22 May 1924, *4081;* Emigrant Creek, 7 April 1925, *4149;* Little Applegate River near Ruch, 11 April 1925, *4219;* Snow Mountain, Siskiyou Mountains, 9 June 1925, *4364, 4366;* Jenny Creek,

25 May 1925, *4288;* Corral Creek, 27 May 1925, *4343;* Chinquapin Mountain, 27 May 1925, *4340a;* confluence of Corral and Beaver creeks, 21 June 1925, *4378;* Tolman Springs, Siskiyou Mountains, 28 March 1926, *4576;* Tyler Creek, 29 March 1926, *4584;* Sterling Creek, Applegate Valley, 6 April 1926, *4597;* Grizzly Butte, 19 May 1926, *4634;* south slope of Siskiyou Mountains, 26 April 1928, *5402;* Pilot Rock, Siskiyou Mountains, 18 June 1928, *5542;* Keene Creek, 30 April 1930, *6150;* Trail Creek, Rogue River, 29 April 1930, *6149;* Evans Creek near Wimer, 21 April 1932, *7076;* Evans Creek, 21 April 1932, *7077, 7080.* Josephine County: near Gold Hill, Rogue River, 8 April 1925, *4136;* Rogue River near Grants Pass, 9 April 1925, *4168;* near Grants Pass, 9 April 1925, *4170;* Applegate River, 11 April 1925, *4216;* between Grave and Wolf creeks, 6 April 1931, *6649;* near Wolf Creek, 2 April 1931, *6638;* west fork of Williams Creek, 18 April 1932, *7069;* Slate Creek, 7 April 1933, *8312;* west fork Williams Creek, 11 April 1933, *8315;* Cedar Flat trail, Siskiyou Mountains, 6 July 1933, *8735.* CALIFORNIA. Siskiyou County: Klamath River between Seiad Valley and Hamburg, 16 April 1932, *7063.*

Specimens examined. OREGON. Jackson County: highway, Siskiyou Mountains, 9 May 1924, *Abrams & Benson 10178* (DH, PhA); 29 April 1928, *Mrs. Gale 13* (DH, PhA); *and 77* (PhA, US); Wimer, Evans Creek, 11 April 1893, *E. W. Hammond 387* (UC, CA, PhA, NY, US); Medford, 30 April 1929, *Ada T. Klocker* (CA); Jacksonville, 7 April 1913, *L. E. Smith 44* (CA); Ashland hills, 22 April 1930 (fl.), 15 June (fr.), *Henderson 5787* (PhA); Siskiyou Mountains south of Ashland, 22 May 1898, *Applegate 2237* (US); Grizzly Peak, 22 June 1899, *J. B. Leiberg 4141* (US); Sampson Creek, 1 June 1895, *Applegate 710* (US); Ashland, April 1887, *Henderson* (GH, type). Josephine County: near Grants Pass, 27 March 1929, *Lyman Benson 1089* (DH); Wilderville, 29 April 1929, *Doris Kildale 7586* (DH); Sexton Mountain, 28 April 1928, *Mrs. Gale 40* (DH, PhA, US); Thompson Creek, Applegate Valley, 10 May 1924, *Abrams & Benson 10302* (DH); Grants Pass, 28 March 1913, *Lois Dale* (DH); 7 March 1926, *Henderson 5787* (DH, CA); 18 April 1905, *M. S. Baker* (UC); 20 April 1887, *Howell 1280* (UC, NY, US); near Grants Pass, April 1913, *L. E. Smith* (CA, US, GH); Woodville, 1 April 1889, *Jos. Howell* (PhA); Grants Pass, 10 April 1887, *Thomas Howell 656* (GH, cotype); Cascade Mountains, 1893, *Mrs. R. M. Austin* (GH); between Provolt and Murphy, 11 April 1933, *M. S. Baker 7359.* CALIFORNIA. Siskiyou County: Cecilville, Scotts Mountains, 27 April 1929, *Doris Kildale 7489* (DH); Hilt, 25 April 1917, *Mrs. A. E. Stonehouse* (CA).

11. ERYTHRONIUM REVOLUTUM Smith, in Rees' Cyclop. 13: no. 3, 1809. *Erythronium grandiflorum* var. *Smithii* Hook. Fl. Bor. Am. 2: 182. 1840. *Erythronium revolutum* var. *Bolanderi* S. Wats.

Proc. Am. Acad. 26: 129. 1891, in part (see *E. californicum* Purdy). *Erythronium Smithii* Orcutt, West Am. Sci. 7: 129. 1891. *Erythronium revolutum* var. *Johnsonii* Purdy, in Bailey Cyclop. Hort. 548. 1900.

Corm 3–5 cm. long, 5 mm. thick, often the remains of old corms retained in a crowded rhizome-like chain for a number of years; leaves commonly broadly-lanceolate, the widest part near the middle of the blade, acute, the larger sometimes obtuse, rather shortly attenuate to a narrowly winged petiole, 15–20 cm. long, 3–6 cm. broad; scape 15–40 cm. high, those bearing several flowers often flattish and ribbed above, appearing partly fasciate; flowers usually one, sometimes two or three, rarely more, the segments linear-lanceolate, acuminate, acute or sometimes blunt and cucullate, frequently with involute margins, 35–45 mm. long, 7–10 mm. broad (sometimes larger), rich rose-pink without, lighter within, especially the base which is broken by one or two interrupted yellow transverse bands, the outer base usually darker; the median pair of appendages conspicuous, elongate, not strongly inflated, the lateral ones small if present, often reduced to a ridge-like fold of the well developed auricles; filaments very broadly dilated below, 3–4 mm. wide, enveloping the ovary, subulate; anthers golden-yellow, usually closely appressed to the style; style long and filiform, only slightly enlarged above; stigma deeply divided, the lobes strongly recurved; capsule oblong or sometimes slightly attenuate downward, blunt with abruptly narrowed base, 3–4 cm. long, 5 mm. thick.

Distribution: frequent along the coast in openings in forests, margins of swamps and bogs, and along wooded streams; from the Navarro River in the redwoods, southern Mendocino County, California, about 39 degrees north latitude, northward through northern California, Oregon, Washington and southern British Columbia, where it occurs on both sides of Vancouver Island and on the mainland as far north as Kingcome Inlet, latitude about 51 degrees, a distance of over 800 miles. Confined to the humid Transition Zone, and, with rare exceptions, to low altitudes and within perhaps 20 miles of the seacoast. On the Hupa Indian Reservation, northern Mendocino County, California, collections have been made at 2500 to 3500 feet and some 30 miles inland; and in Curry County, Oregon, 15 miles from the coast at about the same altitude. It reaches its greatest development and abundance along the northern coast of Oregon, the region of maximum rainfall. Here I have seen plants 18 inches high with flowers as large as 5 inches across, dark, rich rose-pink in color. In most colonies throughout the range of the species, occasional white individuals occur. This tendency to albinism is more pronounced toward the south end of the range. Otherwise there is remarkable uniformity in

color, basal segment configuration, and morphology. There are certainly no variations worthy of names.

A discrepancy has been noted concerning the date of original publication in Rees' Cyclopedia, some authors giving 1819, others 1809. According to B. D. Jackson (Jour. Bot. 34: 310), the complete set of 39 volumes was issued in 1819, but was published in parts, the one containing *Erythronium* being issued in 1809, making it the earliest publication of our western species of *Erythronium,* antedating *E. grandiflorum* Pursh by 6 years.

Specimens collected. BRITISH COLUMBIA. Vancouver Island: Courtenay, Comox Bay, 18 April 1931, *6666;* Cole Creek, west of Sooke, 20 April 1931, *6671;* Simpson's gardens, Cowichan Lake, 17 April 1931, *6665.* OREGON. Clatsop County: near Nehalem River, 10 April 1931, *6658.* Tillamook County: near Salmon River, 10 April 1931, *6657;* Limestone Creek, near Blaine, 9 April 1931, *6656.* Lincoln County: near Toledo, 8 April 1931, *6655;* near Eddyville, Little Elk River, 8 April 1931, *6653;* Yaquina River, near Chitwood, 8 April 1931, *6654.* CALIFORNIA. Del Norte County: Adams Station, Smith River, 29 March 1931, *6629* and 25 July 1931, *6811* (fruit); Gasquet, 23 April 1930, *6132.* Mendocino County: Leggett Valley, 27 March 1931, *6622;* Navarro River, 19 March 1932, *7019;* McCoy Creek near Garberville, 5 April 1933, *8308.*

Specimens examined. BRITISH COLUMBIA. Vancouver Island: Coal Creek, 21 April 1924, *G. French 7424* (PM); Henderson Lake, 14 June 1916, *W. A. Newcomb 988* (PM, WS); Henderson Lake, 6 April 1916, *C. F. Newcomb* (PM); Ucluelet, Barklay Sound, 2 May 1916, *George Fraser* (PM); Alberni, 27 April 1917, *W. R. Carter* (PM); Alberni, 28 May 1921, *C. F. Newcomb* (PM); Valdez Island, May 1920, *C. F. Newcomb* (PM); Port Rupert, May 1913, *W. R. Carter* (PM); Anderson Lake, west coast, June 1916, *J. P. Babcock* (CA); Effingham Bay, near Ucluelet, 6 May 1909, *John Macoun* (NY); Alberni, May 1915, *W. R. Carter 161* (GH); Alberni, 27 April 1917, *W. R. Carter* (NY). Mainland: Kingcome Inlet, 5 August 1917, *C. F. Newcomb* (PM). WASHINGTON. Jefferson County: Hoh River, 19 April 1925, *I. C. Otis 1418* (WS). Clallam County: near Lake Tyee, 29 April 1925, *I. C. Otis 1426* (WS); Forks, 30 April 1925, *I. C. Otis 1428* (WS). OREGON. Clatsop County: Neahkahnie, 23 April 1920, *W. H. Gorman* (DH). Tillamook County: Nescowin, 22 April 1924, *Mrs. C. E. Evans* (CA); near Tillamook, 21 May 1928, *J. W. Thompson 4113* (DH, OS, US, PhA, NY); Tillamook, 21 April 1920, *Bradshaw 1378* (DH); 31 March 1896, *W. R. Cannon* (NY). Lincoln County: Toledo, 1 April 1924, *L. M. Haskin* (DH); 25 March, *L. M. Haskin* (OS); near Newport, 19 March 1925, *Miss Aiken* (UO); near Chitwood, 22 April 1927, *Fern Duncan* (OS). Curry County: near Brookings, 14 March, *Hatfield* (UO, UC); Carpenterville, 5 June 1929 (fr.), *Henderson 10137* (UO); Snow Camp, 27 April 1931, *Mrs. Leach 3261.*

California. Del Norte County: Adams Station, Smith River, 29 March 1928, *Alice Eastwood 15057* (UC, CA). Humboldt County: Hoopa Indian Reservation, June 1901, *Chandler 1279* (DH, UC, NY, US, GH); Kneeland Prairie, 21 March 1926, *Doris Kildale 1560* (DH); 9 June 1908, *Tracy* (UC, UO); 4 May 1907, *Ethel Tracy* (UC); 4 May 1913, *J. P. Tracy 4059* (NY, US). Mendocino County: redwoods, 1866, *Bolander 4709* (UC, GH, US); Comptche, 1897, *Purdy* (UC); near Navarro River, 19 March 1932, *M. S. Baker 5645* (UC, CA); April 1929, *Mrs. Horstman* (CA).

The Otis collections cited above, are the first recorded from the state of Washington, an account of which was published by Dr. St. John in 1929 (Research Stud. St. Col. Wash. 1: 59). They are deposited in the herbarium of the State College of Washington, Pullman, where I examined them in May, 1931. They are excellent specimens, leaving no doubt as to their identity.

This species is not only of special interest because of its being the first of our western forms collected and named, but by reason of the important and stirring historical events associated with its discovery, in which the sovereignty of the whole Northwest Territory was involved, and in which all of the leading maritime powers of the world were actors. Nootka Sound, because of its excellent harbor and favorable location, was the rendezvous of the explorers and fur traders of the time.

There has been more or less uncertainty concerning the identity and date of the discovery of this plant, but the evidence seems to point to the conclusion that the first specimens were collected in 1793 by the celebrated Scotch physician and naturalist, Archibald Menzies, in the vicinity of Nootka Sound, Vancouver Island. Menzies, as early as 1787, on the English trading ship, "The Prince of Wales," under the command of Captain Colnet, botanized along the northwest coast and again later, on the "Discovery" with Captain George Vancouver on his famous exploring voyages for the British government. Concerning the date of this collection, we can only infer from the circumstances surrounding Menzies' activities during these various voyages. Four visits were made to Nootka (King George's) Sound: in July, 1787; some time in 1788; in August, 1792; and during the month of May, 1793. On the last visit he spent the 21st day of May botanizing, as an entry in his journal shows. The 1787 and 1792 visits were of course too late in the season for flowering specimens of this plant. While no journal of Menzies for the year 1788 has been found, in his journal for 1793 is an entry written at Nootka in which he refers to certain events which took place there "about five years before." This reference establishes the fact that he did collect plants there during the season of 1788; he may have been there that year at the right time to collect flowering plants of *Erythronium*.

During the spring of 1931, my wife and I spent some time on Vancouver Island and the adjacent mainland collecting *Erythronium* and examining material and historical data at the University of British Columbia at Vancouver and at the herbarium of the Provincial Museum at Victoria. At the latter institution, Mr. W. A. Newcomb, Curator, furnished me with much interesting and useful information concerning this species, and later was good enough to secure for me fine specimens from the type locality. These were collected at Friendly Cove, Nootka, by Rev. Father Anthony Terhaar, 7 April 1934. Concerning the date Mr. Newcomb writes: "The flowering season for 1934 has been in many cases fully a month early, which should be noted when comparing with Menzies' dates."

Recently I have had the good fortune to be able to examine Menzies' original collection, deposited in the Kew Herbarium. For the loan of this type I am very greatly indebted to Sir Arthur W. Hill, Director of the Royal Botanic Gardens at Kew. The type sheet holds three separate collections, the one on the right side being the type. Although showing the ravages of nearly a century and a half's time, enough remains to show clearly its identity with the pink *Erythronium* of Nootka Sound. By slightly raising a segment which covers the stamens, the broad subulate filaments, which alone sufficiently characterize the species, can be plainly noted. But even without this examination of the plant, the locality would be sufficient for its identification since there is only one species in the Nootka region, and since there is no reason to doubt that it was collected there by Menzies. Directly under the specimen is written: "*E. revolutum* Smith, Rees' Cyclop. *Erythronium grandiflorum* Ph. [The last specific name added in pencil.] fl. rubr. purp. Kg. George's Sound. A. Menzies, V. I., N. America." [The part following the initials written in pencil.] Other annotations have been added by various botanists even down to the present year, 1935. Next to the type is a specimen evidently of the species named in this paper *E. oregonum*. It bears evidence of having been soaked up for critical examination and may have been a contributing factor to the confusion between the two species mentioned farther on. There is nothing to indicate by whom or where the plant was collected. The third specimen on the sheet bears the label: "*Erythronium revolutum,* Kew Gardens, April 9, 1897. Named by Mr. Baker."

Many references to this Menzies collection are made by botanical writers. In 1840 Hooker (Fl. Bor. Am. 2: 182) published *E. revolutum* as a variety of *E. grandiflorum* Pursh, concerning which he adds this note: "It will be seen that the indefatigable and venerable Menzies was the first to discover this fine and very distinct species, though he only appears to have found a pale purple-flowered variety." This variety Hooker names *E. grandiflorum* var. *Smithii,* notwithstanding the fact that

he says it is the same as *E. revolutum* Smith. With the same inconsistency, while recognizing *E. revolutum* as the older name, he retains *grandiflorum* as the specific name under which he places his three varieties, *Smithii, giganteum,* and *albiflorum.*

Since Hooker's time, while there has been general agreement that Menzies' Nootka plant is the type of *E. revolutum* Smith, some botanical writers who have concerned themselves with the genus have been more or less confused as to the identity of the plant itself. Even as eminent a botanist as J. G. Baker (Gard. Chron. 1876: 138), giving correct diagnosis and habitat, unhesitatingly refers specimens of *E. purpurascens* S. Wats. to *E. revolutum,* after comparing them with the Menzies specimen at Kew which he considers the type. Then some twenty years later (Gard. Chron. 1897: 299) he writes: "Mr. R. Wallace, of Colchester, has lately brought me fine living plants of an Erythronium I was very pleased to see. It has flowers as large and peduncles as tall as in E. giganteum (*Bot. Mag.,* t. 5714), but the flowers are bright mauve-purple instead of creamy-white. The leaves are conspicuously mottled, and the style distinctly tricuspidate, with three falcate stigmas. It agrees with E. revolutum of Smith, described in 1819 [1809] in the thirteenth volume of the *Cyclopedia or Universal Dictionary of Arts, Sciences, and Literature,* edited by Dr. Abraham Rees, F. R. S., F. L. S. This plant was collected by Menzies in Vancouver's Island. . . ." Here he paradoxically makes two distinctly different things equal to the same thing. Farther along, referring to Watson's revision of the genus (1891), he says: "He does not seem to have been acquainted with the genuine E. revolutum, but describes an E. revolutum var. Bolanderi, to which the plant now cultivated by Mr. Wallace and others, under the name of E. Smithii, seems to belong." In Macoun's Catalogue of Canadian Plants (2: 41, 1888) I find, under *E. revolutum:* "Gathered by Menzies on Vancouver Island. Not lately detected unless this may be var. *albiflorum,* which turns pinkish in drying if young specimens are taken." Watson (1891) describes the species as white-flowered, and Piper in his Flora of Washington says: "We incline to the belief that the *E. revolutum* Smith, collected by Menzies on 'King George's Sound' is the plant here called *E. giganteum,"* never realizing that the pink *Erythronium* was common along the coast of his own state; and, following Macoun, Watson makes the startling statement that this plant is no longer found on Vancouver Island where Menzies' specimens were collected.

Howell (Fl. Nw. Am. 1903) seems to have had a correct understanding of the species. In Abram's Illustrated Flora of the Pacific States (1923), it is stated that the flowers are described as white. Aside from the statement that it is "like E.

californicum," the description in Jepson's Manual (1925)[2] is correct.

With reference to Watson's variety *Bolanderi,* mentioned above, the original description reads: "Usually low, 1–3- (rarely 4-) flowered; perianth white with yellowish centre, becoming rose-purple; appendages very prominent.—In the redwoods of Colusa, Mendocino, and Trinity Counties, California." In the Gray Herbarium are six sheets of specimens so labelled in the handwriting of Watson. In addition to having examined all of these sheets, I have explored, and collected *Erythronium* throughout the regions whence they came. Bolander's collection, "4709, Redwoods, Mendocino County, common," as suggested by Mr. Weatherby of the Gray Herbarium, in view of the name given by Watson, might reasonably be designated as the type. The type sheet holds one specimen each of *E. revolutum* Smith and *E. californicum* Purdy, two very distinct species, both common in the redwood region of Mendocino County. Three other sheets hold collections made in the vicinity of Weaverville, Trinity County, by Kleeberger in 1880. These are all clearly *E. californicum,* as is also another sheet, *Rattan 62,* Colusa County. A specimen of *E. revolutum* grown in Purdy's garden at Ukiah, Mendocino County, completes the list upon which Watson seems to have based his variety. *E. revolutum* does not occur anywhere on the east side of the Coast Ranges where the Kleeberger and Rattan collections were made. To add to the confusion, there are in the herbarium of the University of California and in the National Herbarium, duplicates of Bolander's "4709," an examination of which discloses the fact that *E. californicum* is not included. About ten years prior to the publication of his variety, Watson (Bot. Cal. 2: 170) notes: "The purplish variety, collected in the redwoods of Mendocino, (*Bolander,* n. 4709), is probably identical with the form of the plant described by Smith and first discovered by Menzies at Vancouver Island, and may prove distinct."

12. **Erythronium oregonum** sp. nov.

Cormus ca. 5 cm. longus, diam. 10–15 mm.; folia 12–15 cm. longa, 3–6 cm. lata, lanceolata vel oblongo-lanceolata, acuta, rarius oblanceolata, majora saepe oblongo-elliptica, apice saepe rotundata; petioli paululum late alati; scapi plerumque crassi, brunnescentes, 15–30 cm. alti, saepe altiores, uniflori vel pluriflori; alabastra plerumque rubescentia; perianthi segmenta 35–50 mm. longa, 8–12 mm. lata, late lanceolata, marginibus saepe sinuatis, apicibus longo-acuminatis, contortis, textura delicata, candida vel eburnea, basi extus punicea vel brunnescentia basi intus lutea, unilineata vel bilineata, lineis anfractis transversis, aurantiacis, atrorubescentibus vel atrobrunneis; segmentorum appendiculae plerumque quadrisaccatae, saccis inflatis conspicuis

[2] Jepson, W. L., A Manual of the Flowering Plants of California, 1925.

occlusis, lateralibus aliquandum minoribus vel etiam obsoletis, plicis auriculorum repositis; filamenta aliquantum dilatata, 1.5–2.5 mm. lata, subulata, plus minusve patentia, biserialia, jugis insolito inaequalibus; antherae aureae; stylus elongatus gracilis superne gradatim paullo ampliatus, diam. basi ca. 1 mm., apice 1.5 mm.; stigma bifidum, lobis filiformibus valde recurvatis, 4–5 mm. longis; capsula ca. 35 mm. longa, diam. 8 mm., angusti-obovoidea, retusa, in basin angustam aequaliter attenuata.

Type in the Dudley Herbarium of Stanford University, collected in the fir woods near and north of Oregon City, Clackamas County, Oregon, 23 April 1932, *Applegate 7086*. Dedicated to "Old Oregon" which included all of the territory within which the species is found. Oregon City was the early metropolis of Oregon and its territorial capital. There lived Dr. John McLoughlin, the "Father of Oregon"; and nearby, "in the continuous woods where rolls the Oregon," this beautiful plant occurs in great abundance.

A slender, more delicate form is common in the Puget Sound region and northward into British Columbia. The scapes are green, leaves not so strongly mottled, flowers pure white, segment base greenish without, light yellow within and beautifully marked with alternating, transverse, sharply angled zigzag bands of lemon-yellow and reddish-brown. This delicate plant usually occurs in the same localities as the typical stout form, but in separate colonies. It is commonly found in deep moist woods, in leaf-mold, moss and ferns. Of the typical form, the leaves in open situations are often very large, sometimes three inches broad and very strikingly mottled with three rows of dark-brown spots on each margin, with a large central dark area, separated by light green veins.

This species differs from *E. revolutum* Smith principally in the following particulars: strikingly in color of flowers, the white often turning pinkish instead of purplish; the flowers more numerous; the filaments narrower; the segments of the perianth broader, of more delicate texture, often with more slender twisted tips and more definite and contrasting basal markings.

Specimens collected. Oregon. Josephine County: Slate Creek, 9 April 1925, *4172;* 13 April 1925, *4229;* 24 April 1930, *6146;* 4 April 1931, *6640;* 20 April 1932, *7073*. Marion County: Jefferson, Santiam River, 23 April 1932, *7085;* Silverton, 24 April 1932, *7092*. Clackamas County: near Oregon City, 23 April 1932, *7086;* Marquam, 23 April 1932, *7091*. Curry County: Agness, 9 May 1932, *7104;* mountains south of Agness, 10 May 1932, *7115, 7117, 7120, 7123, 7154;* mountains north of Agness, 10 May 1932, *7169;* Lawson Creek, 14 May 1932, *7223;* Horse Sign Butte, *7227*. Washington. Pierce County: American Lake, 12 April 1931, *6659*. Thurston County: near Olympia, 12 April 1931, *6660*. Whatcom County: Bellingham, 14 April 1931, *6661*. Mason County: Purdy Creek, 23 April 1931, *6678*. British Co-

LUMBIA. Vancouver Island: near Duncan, 16 April 1931, *6662;* Royston, 17 April 1931, *6664;* Duncan, *6663;* Courtenay, 18 April 1931, *6667;* Qualicum River, 18 April 1931, *6668;* Nanaimo, 19 April 1931, *6669;* Saanich Inlet, 19 April 1931, *6670;* west of Victoria, 20 April 1931, *6672;* Victoria, 20 April 1931, *6673.*

Specimens examined. OREGON. Josephine County: Hayes Hill, 5 May 1923, *A. R. Sweetser* (UC); Slate Creek, 31 March 1926, *L. F. Henderson 5789* (UO, DH, CA); March 1928, *Mrs. Gale* (PhA); 5 May 1923, *Henderson* (PhA). Washington County: near Gaston, 1 April 1899, *Mabel Hazeltine* (UO); Forest Grove, 7 March 1916, *J. W. Thompson 540* (DH, PhA); 25 March 1894, *F. E. Lloyd* (NY). Multnomah County: Elk Rock, 17 April 1903, *Sheldon* (UO, DH); May 1892, *Fred Drake* (UO); 1918, *M. W. Gorman 4264* (DH); Portland, May 1918, *Gorman* (UO); Sandy, 21 April 1888, *Jessie Millard* (WS); Portland, *Dr. Nevius 873* (US); 6 April 1884, *Henderson* (GH); Sauvies Island, 1 April 1882, *Howell* (NY). Clackamas County: Oswego, 6 April 1889, *Henderson* (DH, UO); Clackamas, April 1896, *Thos. Howell 1554* (NY). Polk County: Monmouth, 2 May 1893, *W. J. Spillman* (WS). Benton County: Corvallis, 8 April 1929, *A. N. Stewart* (UM). Columbia County: St. Helens, *Howell* (UO); Scapoose Prairie, 10 May 1880, *Henderson* (UO); St. Helens, 1 April 1928, *J. W. Thompson 4009* (PhA); April 1882, *Thos. Howell* (PhA, NY). Marion County: Silverton, 15 April 1928, *J. W. Thompson 4097* (US, PhA, NY, DH, GH); Salem, 21 March 1915, *J. C. Nelson 9* (DH); near Salem, 16 April 1933, *Miss Hazzard* (US); near Jefferson, April 1918, *Estella Satchwell* (PhA); Jefferson, 18 April 1918, *M. E. Peck 7787* (GH); Salem, 14 April 1917, *J. C. Nelson 1042* (GH). Curry County: Game Lake, 27 June 1929, *Mrs. Leach 2329* (UO). WASHINGTON. King County: Seattle, 9 April 1889, *E. C. Smith* (WS, UC, DH); 4 April 1889, *Piper* (WS); 5 April, *Lois Clark* (UI); 24 August 1892, *C. A. Mosier* (US); April 1892, *Emma Shumway* (PhA, NY); near Palmer, April 1893, *C. A. Mosier* (NY). Pierce County: Tacoma, 25 April 1908, *Fleet 5432* (UC); 28 March 1896, *Fleet* (WS); 1894, *Gardner* (UC); 29 April 1929, *Lyman Benson* (DH); Steilacoom, *Dr. Kennicott* (NY). Clark County: Lake River, 12 April 1894, *Suksdorf 2327* (UC, UO, US, NY, GH). Clallam County: Sequim, May 1916, *J. M. Grant* (GH). Jefferson County: Hood Canal near Brinnon, 31 March 1931, *J. W. Thompson* (GH). Skamania County: Mt. Prindel, 26 May 1924, *Suksdorf 11714* (UC, DH, WS, CA, US, GH, PhA, NY). Klickatat County: 18 May 1882, *Thomas Howell* (NY). Skagit County: Pleasant Ridge, 13 April 1919, *Thos. Roush* (DH); Hat Island, 6 March 1926, *Edith Hardin* (WS); Whidby Island, 15 May 1897, *N. L. Gardner 289* (WS); Admiralty Head, April 1898, *Piper* (WS); Anacartes, 12 April 1925, *Ethel Hardin* (WS); Blanchard, 28 March 1931, *J. W. Thompson* (GH). Island County: Fidalgo Island, 25 April 1926, *Edith Hardin* (WS). Grays Harbor County: Wreck Creek

Prairie near Granville, June–July 1922, *H. S. Conard 427* (US, NY); *Capt. Wilkes Expedition, 1838–42, Puget Sound and interior, 364, 820* (US); Montesano, May 1919, *J. M. Grant* (NY). British Columbia. Vancouver Island: Victoria, 10 April 1912, *J. R. Anderson* (WS); Thetis Lake, 9 April 1909, *Anderson* (WS); Samilo Arm, 24 April 1905, *Anderson* (WS); Alberni, May 1913, *W. R. Carter* (PM); Dallas Road, 2 April 1899, *C. F. Newcomb* (PM); Highland Lake, 24 April 1921, *Miss D. Hill* (PM); Gordon Head, 27 April 1917, *M. Watson* (PM); Cedar Hill, 16 March 1915, *F. Kermode* (PM); Lost Lake, 21 April 1921, *J. R. Anderson* (WS); Victoria, *Mrs. Kelly* (CA); near Victoria, 2 April 1908, *John Macoun* (US, GH); May 1893, *John Macoun 5960* (US, GH); May 1881, *A. J. Hill a2635* (PhA); Cedar Hill, May 1887, *John Macoun* (GH); Alberni, May 1915, *W. R. Carter 1615* (GH); Renfrew District, 1 August 1902, *C. O. Rosendahl 1836* (NY); Cedar Hill, 16 April 1887, *John Macoun* (NY); near Victoria, 20 April 1918, *J. R. Anderson* (NY); 1874, *Miss Mitchell* (US). Mainland: Deadman River, 4 May 1918, *J. R. Anderson* (WS); Lower Frazer River, 1859, *Dr. Lyall* (GH).

Distribution: throughout the Transition Zone; southwestern Oregon, Josephine County, in the lower Applegate River region, and Curry County, in the mountains of the Rogue River; west of the Cascade Mountains, from central Oregon northward through northern Oregon, Washington, the mainland coast of southwestern British Columbia, and the east coast of Vancouver Island. Although occurring within the Columbia River Gorge as far as Cape Horn, it is never found east of the Cascade Range.

The following contacts with other species have been noted: with *E. revolutum* Smith at Courtenay, northeast coast of Vancouver Island, where many hybrids were noted; in Curry County, Oregon; in Josephine County, Oregon, with *E. Hendersonii* S. Wats. and *E. citrinum* S. Wats. The last is particularly interesting in that it is one of the few instances to come under my observation where three species were found intermingling; and also because of the striking results of hybridization in which all three species are involved. There were to be seen many singularly beautiful color forms combining the contrasting colors of *E. Hendersonii* with the white of the other two species, as well as exhibiting varied morphological and teratological combinations.

For nearly a century this familiar plant has been known erroneously as *Erythronium giganteum* Lindl. (Bot. Reg. sub pl. 1786. 1835); or as *Erythronium grandiflorum* var. *albiflorum* Hook. (Fl. Bor. Am. 2: 182. 1840).

The type of *Erythronium giganteum* Lindl. is in the Lindley Herbarium, which is included in the Cambridge Herbarium, Botany School, Cambridge, England. I am greatly indebted to Mr. W. T. Stearn, Librarian of the Lindley Library of the Royal Horticultural Society, Westminster, for a photograph of the type

sheet. I also have from him his drawings and measurements of the original, together with his notes on a critical examination of the same which he kindly made for me. Of the drawings and measurements, the most significant are those of the filament, 1 mm. wide at the base. The type sheet holds two specimens. The first is a plant *branched at the leaves,* one with two, the other with three flowers. This specimen is labelled "Type *Erythronium giganteum* Lindl. Botanical Register 1786. (1836)," and in Lindley's handwriting (according to Mr. Stearn) "Eryth. giganteum B. Reg. 1786. N. W. America Douglas 1826." Referring to his journal for the year 1826, we find that Douglas spent the early part of the year at Ft. Vancouver with Dr. McLoughlin, Chief Factor of the Hudson's Bay Company. From the 1st to the 20th of March it rained every day, during which time he was engaged in packing boxes of specimens to be shipped to England. It does not seem that he did any plant collecting during this time other than some mosses which he mentions. Indeed, ordinarily this was too early in the season for most flowering plants. Late in the afternoon of March 20th, he left Ft. Vancouver by boat with a Hudson's Bay Company trapping expedition bound for the upper Columbia region. There was no opportunity for collecting until he was long past the easternmost limits of the range of the white-flowered plant heretofore known as *Erythronium giganteum* Lindl. or *Erythronium grandiflorum* var. *albiflorum* Hook., and well within that of the yellow-flowered *Erythronium grandiflorum* of Pursh. On this journey Douglas' plants were numbered consecutively, beginning with number one. On April 27th, at Kettle Falls (Ft. Colville), he collected his number 37, which he identified as *"Erythronium grandiflorum* of Pursh." He remarks that "this exceedingly beautiful plant came under my notice fifteen or sixteen days ago, but being not then in blossom I took it for *Fritillaria;* abundant over all the undulating country, under the shade of solitary pines, in light dry soils; it has a most splendid effect in conjunction with *Dodecatheon* and a small species of *Pulmonaria;* omit not to procure seed and roots of such a desirable plant." There appears to be no evidence to indicate that Douglas made any other flowering collections of *Erythronium* during the year 1826.

Plate 1786, volume 21, Botanical Register, 1836, shows a plant with golden-yellow flowers, unmottled leaves, slender filaments and red anthers. This is clearly typical *Erythronium grandiflorum* Pursh. Following the description of this species, appearing as a footnote, is the original publication of Lindley's *Erythronium giganteum.* The two line Latin description could just as well apply to almost any other species. In his remarks accompanying his diagnosis, he says that it "is most remarkable for having *an irregularly branched scape."* So that his species seems to have been based primarily upon its manner of branching. The type specimen is a "sport" to begin with, branching as

it does *at* the leaves instead of the usual way, more or less distantly *above* the leaves. The only excepion to this rule is the California species *E. multiscapoideum* (Kell.) Nelson & Kennedy. Four years later W. J. Hooker in reducing Lindley's species to a variety of *E. grandiflorum,* characterizes it as having 2 to 5 *yellow* flowers, habitat the "Summit of the low hills near the junction of Spokan River with the Columbia, and in the vallies west of the Rocky Mountains, often in blossom before the snow has disappeared. *Douglas.*" This publication of Hooker's further bears out the assumption that the type of *E. giganteum* was collected by Douglas in the Kettle Falls region.

As discussed in this paper under *Erythronium idahoense* St. John & Jones, Geyer refers to Douglas' collection (in conjunction with his own botanizing in the same region in 1844), as a "bright golden-yellow species with brown anthers," which sufficiently identifies the plant as typical *E. grandiflorum* Pursh.

The second species held by the Lindley type sheet seems specifically identical with the type specimen. This bears four flowers, and is labelled "No. 49. *Erythronium giganteum.* Near the Koutani River, lat. 49′ 20″, elevation 3400 ft. Growing in the crevices of granite rocks." In 1827, coincidentally, we find Douglas leaving Ft. Vancouver on the same day of the month as his departure the previous year. To quote his journal: *"March 20th*—By the annual express and in company with Dr. McLoughlin, I left Ft. Vancouver for England. . . . I walked the whole distance from this place to Ft. Colville on the Kettle Falls, which occupied twenty-five days. . . . The beautiful *Erythronium maximum* and *Claytonia lanceolata* were in full bloom among the snow." Under the date of 13th to 17th of April: "Gathered a few bulbs of *Claytonia lanceolata, Lilium pudicum,* and roots of *Erythronium grandiflorum.*" And April, *"Thursday, 19th.* Near McGillivary's or Cootania River. Of herbaceous plants *Ranunculus* sp., *Claytonia lanceolata,* and *Erythronium grandiflorum* in flower; a few of the latter I laid in."

That *Erythronium giganteum* Lindl. is synonymous with *Erythronium grandiflorum* Pursh, there is no longer any doubt. The establishment of the type locality alone is sufficient to remove any doubt, even without the identity of the specimen itself, along with the corroborative circumstances heretofore recited.

Discarding the name *E. giganteum,* the only possible name available would be *E. grandiflorum* var. *albiflorum* Hook. This Hooker describes: "caule elatiori unifloro, flore albo." He does not state whether or not he had before him the "white-flowered" plant upon which he based his variety, nor does he give any other information which might lead to the identity of a type.

In 1868, J. D. Hooker (Bot. Mag. pl. 5714) published a fine colored plate showing clearly the plant here discussed. He refers it to *E. giganteum,* and assumes that it is the same as *E. grandiflorum* var. *albiflorum* Hook. Concerning the original of

the plate, Hooker says: "It is a native of North-west America, and was communicated from the Edinburgh Botanic Garden in April of the present year." He further states: "*E. giganteum* was discovered by Douglas, who does not notice the colour of the flower, nor does Lindley, in his diagnosis of it above quoted. They would appear to be white in Douglas' own specimens preserved in the Hookerian Herbarium, but in the 'Flora Boreali-Americana' they are stated to be yellow; and another variety is noticed as having white flowers (viz. δ. *albiflorum*), to which the present plant no doubt belongs." This does not clear up the identity of the variety *albiflorum*. Hooker seems to have only assumed that Douglas' herbarium specimens had always been white, when they probably were originally yellow; so that there is no evidence to indicate that the variety was not based upon the same material as the type.

Following Hooker's descriptions (Fl. Bor. Am. 2: 182. 1840). of his varieties of *Erythronium grandiflorum* Pursh (*minor, giganteum, albiflorum,* and *Smithii*), is an account of their habitats in which confusion is caused by an error due to an apparent misprint in the text. This is referred to by Sir Arthur W. Hill in his letter accompanying the types *E. revolutum, E. grandiflorum* var. *giganteum* and *E. grandiflorum* var. *albiflorum* sent to me from Kew; concerning which he says: "It has been very difficult to decide which are the type specimens of Hooker's varieties of *E. grandiflorum,* since he did not write them up himself, and they have since been wrongly written up (*e.g. E. grandiflorum* var. *revolutum* Hook., which does not exist) by other botanists. The type of var. *albiflorum* was not collected by Menzies at Ft. Vancouver, but by Douglas. The plant collected by Menzies was the type collection of Smith's *E. revolutum;* it was a purple-flowered plant, and was named var. *Smithii* by Hooker in Fl. Bor. Am. 2: 182. The erroneous application of Menzies' name to variety *albiflorum* is apparently due to a misprint in the text of Fl. Bor. Am. 2: 182. Here, in the accounts of the habitats, "α" is repeated, and var. "δ" does not appear at all. It is clear that the first "α" applies to var. *minor,* the second "α" applies to var. "β" *giganteum,* "β" applies to var. "γ" *albiflorum,* and "γ" to var. "δ" *Smithii.* This fits in with the rest of the evidence, and with the herbarium specimens, and it is evident that vars. *giganteum* and *albiflorum* were collected by Douglas, and var. *Smithii* by Menzies."

It therefore necessarily follows that the types of both vars. *giganteum* and *albiflorum* were collected "near the junction of the Spokane River with the Columbia," and that the first was yellow and the second was white; in which case var. *albiflorum* could be nothing else but *E. idahoense* St. John & Jones, since it is the only white-flowered species in all the region east of the Cascade Mountains, and obviously not the white-flowered species occur-

ring west of this range, and known so long as *E. giganteum* Lindl. or *E. grandiflorum* var. *albiflorum* Hook.

I have before me a sheet of plants from Kew purporting to hold the types of Hooker's varieties *giganteum* and *albiflorum* of *E. grandiflorum* Pursh. Attached to this is what appears to be an original label in the handwriting of Douglas reading: *"Erythronium maximum.* On the summit of the low hills, near the junction of Spokane river and vallies of the Rocky Mountains. 1826." This is identical with that of the collection in the Lindley Herbarium which is the basis of *E. giganteum* Lindl. and, as I have long suspected, doubtless a part of the same collection. To this Kew sheet from time to time various annotations have been made, apparently representing the guesses of other botanists as to the identity of the plants. Of these, the latest designate the types of Hooker's varieties *giganteum* and *albiflorum,* and are dated 1934. The first name is written under a three-flowered specimen, the second under a two-flowered one. Above this last is the third specimen of the sheet under which is written: "Ft. Vancouver, Tolmie." This has only a single flower which corresponds to the number in Hooker's description of his variety *albiflorum,* all of which does not tend to clarify matters concerning the identity of variety *albiflorum.* All of the plants on the sheet look to me like *E. grandiflorum* Pursh, just as I think they did to Douglas himself, his manuscript name *E. maximum* being a synonym of that species. In the condensed report of his two journeys through the Spokane country, Douglas uses the name *E. maximum,* while in the long account expanded from this, he names the same collections *E. grandiflorum.*

12a. Erythronium oregonum subsp. **leucandrum** (Applegate) comb. nov. *Erythronium giganteum* subsp. *leucandrum* Applegate, Contr. Dudley Herb. 1: 189. 1933.

Apparently this subspecies differs from the species only in having white anthers instead of golden-yellow ones.

Type in the Dudley Herbarium of Stanford University, no. *207816;* collected in low brushy foothills, in open yellow pine and oak woods, near the mouth of Evans Creek, Rogue River, western edge of Jackson County, Oregon, 8 April 1925, *Applegate 4161.*

The following additional collections were made by myself: Jackson County: near Prospect, 29 April 1930, *6147* and *6148.* Josephine County: near and north of Grants Pass, *6648;* Grave Creek, *6639;* Wolf Creek, 2 April 1931, *6637.* Douglas County: Cow Creek, *6636;* Canyon Creek, *6635;* Myrtle Creek, *6634;* 13 miles south of Roseburg, *6633;* near Oakland, 6 April 1931, *6650;* near Yoncalla, *6651;* near Drain, *6652.* Lane County: near Eugene, 6 April 1931, *6652a.* Coos County: north fork of the Coquille River, 31 March 1931, *6631.*

Specimens examined. OREGON. Lane County: Eugene, 4 April 1905, *Sheldon* (UO); near Eugene, 1 April 1907, *Elsie Davis* (PhA). Douglas County: Drain, *Sheldon* (UO); Canyon Creek, 27 March 1929, *Lyman Benson* (DH); near Canyonville, 28 April 1928, *Mrs. Gale 48* (DH, PhA); near Elkton, 1900, *F. H. Andrus 59* (US, NY); Cow Creek Canyon, 8 April 1887, *Thos. Howell* (GH). Josephine County: Grants Pass, 1 April 1899, *Howell* (UC); Louse Creek, April 1913, *Lois Dale* (DH); Sexton Mountain, 7 April 1927, *J. W. Thompson 2061* (DH); Woodville, 11 April 1889, *Jos. Howell* (PhA); 4 miles north of Grants Pass, 12 April 1933, *M. S. Baker 7357* (DH). Jackson County: Wimer, Evans Creek, 24 April 1893, *E. W. Hammond 388* (CA, NY, US).

Distribution: common throughout the Transition Zone; between the Cascade Mountains and the Coast Range from central Oregon southward to the Rogue River; occasionally found west of the summit of the mountains of the coast in Lincoln and Benton counties, and perhaps in Douglas County. Dr. Helen M. Gilkie of the Department of Botany, Oregon State College, reports this form as far north as Beaverton, Washington County; and Professor L. F. Henderson of the University of Oregon writes me that he has seen the typical form in Lane County. Thus it will be seen that the two overlap for about one hundred miles. However, the occurrence of each at the outer edges of their limits is rare. The species in typical form occurs from Benton and Linn counties northward, while from Lane County southward it is seldom seen. While both forms are found in the central part of the state, they seem to occur in separate colonies. Although the white-anthered form has not been reported from Marion County, the occasional occurrence of individuals with purple anthers in the southern part of that county suggests the probability of contacts, since a change in anther-color is one of the common results of hybridization in the genus.

Erythronium oregonum subsp. *leucandrum* is extremely abundant over much of the range above outlined, and especially so in the open, wooded hills of Douglas and northern Josephine and Jackson counties. In the southern part of the range this subspecies is associated with *E. Hendersonii* S. Wats., where interspecific hybrids are common.

13. ERYTHRONIUM CALIFORNICUM Purdy, Flora and Sylva 2: 253. 1904. *Erythronium revolutum* var. *Bolanderi* S. Wats. Proc. Am. Acad. 26: 129. 1891, for the most part (see *E. revolutum* Smith).

Corm rather large, with conspicuous membranous coats; leaves strongly mottled with dark green to brownish irregular areas separated by light colored veins, 10–15 cm. long, 2.5–5 cm. broad, from oblong-lanceolate or oblong-ovate to oblong, the larger commonly rounded at the apex and sometimes ob-

lanceolate, the smaller acute to acutish, petiole short and broadly winged; scape 10–25 cm. high (or higher), frequently stout, often reddish in color, bearing usually one to three flowers, often several, when frequently the pedicels arise from a common point above the leaves; flower buds often reddish or brownish; the perianth segments broadly lanceolate with blunt and often cuculate apices 25–35 mm. long, 7–10 mm. broad, white to creamy-white, shading at the base into pale greenish yellow, usually marked transversely by an irregular, continuous or interrupted band of deeper yellow, orange, or sometimes brown, the edges of the color zones indefinite; filaments slender and of nearly uniform width throughout; anthers white; style rather stout but slender at base, moderately clavate, 8–10 mm. long; stigma lobes commonly short (1–2 mm.), stoutish, erect or spreading, infrequently longer and more or less recurved; ovary often pinkish; capsule rather narrowly obovoid with rounded apex.

This plant was formerly confused with the northern *E. oregonum* Applegate, but it is easily distinguished from that species by its slender filaments, shorter and stouter style, shorter, thicker and more erect stigma lobes, and less striking perianth segment markings. The two species are separated geographically by about 75 miles, and topographically by the Klamath River Gap and the Siskiyou cross range of mountains. The intervening territory is occupied by the "Siskiyou Island" endemics, *E. citrinum, E. Hendersonii,* and *E. Howellii* (all described by S. Watson). There is an intrusion of *E. klamathense* Applegate along the summit of the Siskiyou Mountains and locally at the north end of the Trinity Mountains. *Erythronium grandiflorum* var. *pallidum* St. John occurs on the higher points of the two last mentioned ranges. *Erythronium californicum* Purdy is associated with *E. revolutum* Smith along the coast of Mendocino and Humboldt counties, and in southern Lake County in separated from *E. helenae* Applegate by Cobb Mountain.

Distribution: common in upper Sonoran and Transition zones of the Coast Ranges and adjacent foothills of Sonoma, Mendocino, Lake, Colusa, Glenn, Tehama, Trinity, Shasta, and Humboldt counties, California. Ranging from near sea level to above 2500 feet.

Described from plants collected by Purdy in the vicinity of Ukiah, Mendocino County, California.

Specimens collected. California. Mendocino County: near Laytonville, 27 March 1931, *6623;* near Cummings, 5 April 1933, *8306*. Lake County: hills west of Kelseyville, 24 March 1931, *6611;* Scotts Valley, 25 March 1931, *6612;* hills west of Lakeport, 25 March 1931, *6620;* near Pine Grove, north base of Cobb Mountain, 31 March 1934, *8872;* Hopland grade, 31 March 1934, *8878*. Tehama County: near Bennett Spring, 6 April 1930, *6115;* Mud Flat, *6118*. Glenn County: below Alder Spring, 17 April 1930, *6122;* near Begum, Bully Choop Mountains, 13 April

1932, *7046*. Shasta County: near Begum, 13 April 1932, *7045*. Trinity County: near Weaverville, 14 April 1932, *7050;* Fawn Lodge, Trinity Mountains, *7055*.

Specimens examined. California. Trinity County: Weaverville, 2 May, 30 May, and 30 June (fruit) 1880, *G. R. Kleeberger* (GH, cotype *E. revolutum* var. *Bolanderi* S. Wats., CA); near Weaverville, 22 April 1915, *Anna Junkans* (CA). Shasta County: Redding, 3 April 1922, *Ruth Carredet* (CA). Glenn County: Newville-Covello road, 27 April 1916, *Heller 12342* (CA, PhA, NY, GH, US). Lake County: near Bartlet Spring, 6 May 1928, *Carl Wolf 1976* (DH); 6 May 1928, *L. R. Abrams 12388* (DH); Lakeport, April 1917, *G. Bentley* (DH); High Valley, April 1902, *Agnes Bowman* (DH); road to Mt. Sanhedrin, 25 May 1925, *Alice Eastwood* (CA); Mt. Sanhedrin *Eastwood 12963* (CA); between Hopland and Lakeport, 12 May 1903, *C. F. Baker 3202* (US, GH); Scotts Valley, 23 March 1930, *Lyman Benson 1962* (GH); Mt. Sanhedrin, 29 May 1927, *Bacigalupi* (DH); Colusa County: Black Butte, June 1882, *V. Rattan* (GH, cotype). Sonoma County: Cloverdale, 25 June 1877, *Rattan* (DH); Gualala River, *M. S. Baker* (DH, UC); near Healdsburg, May 1880, *Rattan* (GH); Cloverdale, 15 March 1898, *Setchell* (UC, GH). Mendocino County: 1866, *Bolander 4709* (GH, in part type of *E. revolutum* var. *Bolanderi* S. Wats.); Ridgeway highway, 1 April 1928, *Doris Kildale 4373* (DH); Yorkville, May 1922, *Hall Burgess* (DH); Mt. Sanhedrin, 1884, *Rattan* (DH); Sherwood Valley, 17 June 1899, *Blasdale* (DH); 29 May 1899, *Blasdale 1043* (UC); Rowes, 11 May 1902, *Chandler 1055* (UC); Potter Valley, April 1894, *Congdon 880* (UC); Ukiah, 10 March 1925, *Billie Held* (CA); Ukiah, April 1929, *Vivian Giles* (CA); May 1876, *Jos. Clark 201* (NY); near Handley's, May 1903, *Jas. W. McMurphy 176* (NY, US); near Ukiah, 23 March 1902, *Alice Eastwood* (NY, US); 1895, *Carl Purdy* (GH). Humboldt County: McClellan Mountain, 1 May 1928, *Doris Kildale 5983* (DH); Kneeland Prairie, 21 March 1926, *Doris Kildale 1579* (DH); 4 May 1913, *Tracy 4058* (UC, US); Harris, 15 April 1906, *Ethel Tracy* (UC); near Hoopa, March-April 1902, *Mrs. Manning* (UC); Willow Creek, 27 April 1924, *Tracy 6639* (UC); between Three Creeks and Willow Creek, 30 April 1922, *Tracy 6037* (UC); Hoopa Valley, April 1888, *C. C. Marshall* (UC).

14. Erythronium helenae Applegate, Contr. Dudley Herb. 1: 188. 1933.

Corms large (6–8 cm. long, 10–15 mm. thick), propagating by sessile offsets, or by very short runners, forming under favorable conditions, compact clumps, the filiform roots produced in a large dense mass; leaves strongly mottled, varying in outline from ovate or elliptical to oblong-lanceolate or lanceolate, and obtuse to acute, the base narrowing either abruptly or attenuately to a winged petiole; scape commonly about 2 dm. high or

higher, abruptly bent at right angles close up to the flower; flowers one or more, large and showy, the segments 35–40 mm. long, 10–15 mm. broad, usually broadly lanceolate with blunt and cuculate apex, the upper part pure white (the outer set sometimes more or less streaked with pink on the back), the base golden-yellow without spots or bands of any kind, the color areas very definite, the two median appendages slightly elongated inflated sacs, the auricles transversely folded to form a slight connecting ridge; filaments slender with little or no taper, shorter than the young anthers, these golden-yellow; style but little enlarged above, usually strongly declined or gradually and completely curved downward; stigma lobes short, stout, entire, and erect to spreading; capsule 15–20 mm. long, 8–10 mm. thick, truncate, the angled sides cuneate in outline.

Type in the Dudley Herbarium of Stanford University, collected in the volcanic crater region of Mt. St. Helena, Mayacama Range, northern Napa County, California, on very steep wooded northerly slope, in well watered volcanic soil and leaf mould, 4 April 1932, *Applegate 7037*. Other collections have been made by myself as follows: the same station as the type, 22 March 1932, *7031;* Gallagher's ranch, north base of Mt. St. Helena, southern Lake County, 23 March 1931, *6610,* 21 March 1932, *7029* and 1 April 1933, *8302;* near and north of Gallagher's ranch, 11 March 1934, *8841;* St. Helena Creek, Napa County, near Lake County line, 11 March 1934, *8842;* west slope of Mayacama Mountains above Pine Flat, Sonoma County, *8855;* east slope of Mayacama Mountains, Putah Creek, Lake County, 31 March 1934.

Specimens examined. CALIFORNIA. Napa County: Oat Hill, March 1900, *Miss Armstrong* (UC); Pope Valley, 1 March 1921, *Mrs. Clara Hunt,* 10 March 1924, *Mrs. Hunt* (CA). Lake County: Mt. St. Helena, 20 April 1892, *E. L. Greene* (NY); Middletown grade, Mt. St. Helena, 15 May 1893, *W. L. Jepson* (US); St. Helena Creek, 4 April 1931, *D. D. Keck 1087* (PhA, GH); Mt. St. Helena, 10 March 1925, *Jessamine Raymond* (CA); Mt. St. Helena, 27 March 1927, *Elizabeth Wright* (CA); St. Helena Creek, 21 March 1926, *J. T. Howell 1715* (CA).

Perhaps our most local species, unless it be *E. tuolumnense* Applegate of the Sierra Nevada, little more than one hundred miles to the east. Found only in the northwest corner of Napa County, the southwest border of Lake County, and the northeast corner of Sonoma County; confined to the Mayacama or Middle Coast Range, the central and culminating point of which is Mt. St. Helena, and extending from the Crater or Palisades region (lying between Calistoga and Pope Valley, Napa County), northwesterly, along the boundary line between Lake and Sonoma counties to the south slope of Cobb Mountain, the upper waters of Putah Creek, and Pine Flat, upper Sulphur Creek region on the west. As far as I know this is the only *Ery-*

thronium in Napa County. From the north base of Cobb Mountain and the canyon of Sulphur Creek to the west, *Erythronium californicum* Purdy is common northward, but the two species seem definitely separated by these natural boundaries.

Resembling *E. californicum* Purdy, but differing from that species particularly in having bright yellow anthers instead of white ones, perianth segments with clear-cut color areas instead of mixed and indefinite ones, and by the habit of producing clumps of corms by sessile offsets. A strikingly beautiful and responsive plant in cultivation. In the garden the stimulation of the growth of corm offsets is especially noticeable, clumps of as many as one hundred being produced in a few years.

15. Erythronium multiscapoideum (Kell.) Nelson & Kennedy, Muhlenbergia 3: 137. 1908. *Fritillaria multiscapoidea* Kell. Proc. Calif. Acad. 1: 46. 1855. *Erythronium grandiflorum* var. *multiscapoidea* A. Wood, Proc. Phila. Acad. 1868: 166. *Erythronium Hartwegii* S. Wats. Proc. Am. Acad. 14: 261. 1879.

Corms very short, about 10 mm. long, 5 mm. thick, oblong-ovoid, producing new ones from the base very freely on the ends of long filiform offshoots or runners; leaves commonly oblanceolate, acute (the larger sometimes obtuse), narrowed to a short, winged petiole, occasionally alternate, sometimes with a third leaf and, rarely, with four; flowers usually solitary, otherwise borne on naked elongate umbellate pedicels of unequal length, branching from the stem at the leaves, sometimes a pedicel branching and bearing a second flower on a short subpedicel, or rarely the pedicels branching at some distance above the leaves as in the other species; perianth segments white to greenish-white or creamy-white with pale greenish-yellow base, the center of this area sometimes darker, lanceolate to oblong-lanceolate, the apex commonly blunt and more or less cuculate, 25–40 mm. long, 7–12 mm. broad; appendages often not well developed, sometimes with four small somewhat inflated sacs, the lateral ones occasionally reduced to a ridge-like fold, or all four represented by a continuous ridge and the auricles appearing only as a slight widening of the base; filaments about 5 mm. long, thin and filiform, nearly uniform in width (less than 1 mm.); anthers white, 8–10 mm. long before dehiscence; style slender, slightly clavate, about 8 mm. long, 1 mm. or less thick; stigma very deeply cleft, filiform, lobes entire, strongly recurved, often forming a complete circle; capsule relatively short, oblong-ovoid, about 10 mm. long, 5 mm. thick.

Relative to the length of the style, the stigma lobes are longer than those of any other species. Sometimes the filament lengths of the two sets are nearly the same; rarely the young anthers vary slightly in length. The flowers are very fragrant. The habit of producing runners is not shared by other western species; the small, short corms are much like those of the

eastern and the old world species, and produce offsets in the same manner as *E. americanum* Ker.-Gawl. and *E. albidum* Nutt., two of the eastern species. Our plant resembles the latter more closely in its divided stigma with recurved lobes, but differs from that species in being provided with inner-segment processes. The inflorescence is unlike that of any other known species.

Distribution: Transition Zone; wooded bank of the Sacramento River in the northwest corner of Butte County; Digger and yellow pine woods of the foothills of the Sierra Nevada from southeastern Tehama and Butte counties, southward to Mariposa County, California. More often found on brushy hillsides in the regions where Digger and yellow pines overlap.

The type collection, sent in 1855 from Placerville, Eldorado County, California, to Dr. Albert Kellogg, California Academy of Sciences, if preserved in the first place, was destroyed by the earthquake and fire of 1906. In describing the plant as a "Fritillaria" Dr. Kellogg suggested that it would "ultimately require a new genus."

In publishing the new combination in recognition of Kellogg's specific name, Nelson and Kennedy erroneously included as a synonym *E. purpurascens* Wats. rather than the true synonym *E. Hartwegii* Wats. This confusion doubtless arose from the fact that both species were collected in the same region, and from Watson's treatment of the synonomy of the two plants. The type of *E. Hartwegii* was collected by Theodore Hartweg (288) under the auspices of the London Horticultural Society (Jour. Lond. Hort. Soc. 3: 221. 1848), in the latter part of April, 1847, in yellow pine woods of the foothills of the Sierra Nevada, near Pine Creek, in what is now southeastern Tehama County, California. The following year Bentham (Pl. Hartw. 339, No. 1989), not recognizing the plant as new, referred it to *E. grandiflorum* Pursh. Curiously enough, in his original publication, Watson included both *Fritillaria multiscapoidea* Kell. and *E. grandiflorum* var. *multiscapoidea* Wood in the synonomy of *E. purpurascens*, thus confusing two of his own species.

In the narrative of his Pacific Coast trip of 1866 (Proc. Phila. Acad. 1868: 166), Dr. Alfonso Wood records having seen in the Torrey Herbarium a collection from the Sacramento Valley by Dr. Stillman. To this collection he gives the name *E. grandiflorum* var. *multiscapoidea,* with "Scapes several, all radical, each 1-flowered." This description sufficiently characterizes Dr. Kellogg's "Fritillaria." The Stillman collection came under my observation recently in an examination of the *Erythronium* material in the herbarium of the New York Botanical Garden which includes the Torrey Herbarium.

From the foregoing account it will be seen that Dr. Wood was the first to recognize the plant as an *Erythronium,* and the first to apply Kellogg's name to the right species. Dr. Abrams

in "The Illustrated Flora of the Pacific States," was the first to publish the correct alinement under the new combination.

Specimens collected. California. Eldorado County: near American River between Coloma and Auburn, 28 April 1929, *5551*. Nevada County: Grass Valley, 30 April 1929, *5552*; American Ranch Hill, near Grass Valley, 30 April 1929, *5554*. Yuba County: 5 miles north of San Juan, north fork of Yuba River, 1 May 1929, *5555*. Mariposa County: 8 miles northwest of Mariposa, 18 March 1931, *6608*. Butte County: 12 April 1932, near Cana, Sacramento River, *7041*.

Specimens examined. California. Butte County: Los Verjils, 24 April 1920, *Junea Kelly* (CA); Rock Creek north of Chico, 19 March 1915, *Heller 11774* (CA, DH, PhA, NY, US, GH); 12 April 1889, *Miss Patterson* (DH); Butte Creek, May 1898, *Mrs. Bruce 2011* (DH, NY, US); March 1899, *Mrs. Austin* (UC); Chico, 1883, *Mrs. Austin* (US); Little Chico Creek, 6 March 1883, *Mrs. Austin* (GH); Chico, April 1879, *Mrs. J. Bidwell* (GH). Plumas County: 1875, *Mrs. M. E. P. Ames* (GH). Sierra County: Downieville, 15 April 1928, *Wm. Vortriede* (CA); Forest City, May 21 1854, *J. M. Bigelow, Whipple Expedition* (NY). Tehama County: near Pine Creek, April 1847, *Hartweg 288* (NY, isotype, GH, type). Eldorado County: Kelsey 21 April 1883, *M. E. Jones* (CA, NY); between Eldorado and Placerville, 7 April 1911, *Heller 12301* (CA, DH, GH, PhA, NY, US); Placerville, May 1923, *Alice King* (CA); near Georgetown, 26 March 1927, *Eastwood 14186* (CA); near Placerville, 13 April 1929, *G. T. Benson* (DH); Nashville, 7 April 1902, *G. P. Rixford* (US, GH, NY); Coloma, *Maj. Rich* (NY). Yuba County: Smartsville, April 1921, *Mrs. D. C. McGanney* (CA, GH); Brownsville, 1880, *Rattan* (DH). Mariposa County: near Mariposa, 21 April 1929, *Ivan Branson* (CA, UC); April-May, *Congdon* (UC); 15 April 1895, *Congdon* (UC, DH, UO); Mt. Bullion, May 1905, *Mrs. Chas. Derby* (UC); Benton Mills Trail, 8 April 1893, *Congdon* (DH). Placer County: Auburn, 20 April 1919, *Georgia Bentley* (DH); Auburn, 5 April 1891, *Sonne* (UC); Auburn, 1860–67, *Bolander 4527* (UC, US, GH). County not given: "Valley of the Sacramento," 1850, *Dr. Stillman* (NY); *Thos. Bridges 332* (US, NY, GH); 1880, *C. C. Parry* (US).

Dudley Herbarium, Stanford University,
February 7, 1935.

NOTES AND NEWS

Dr. F. L. Foxworthy, formerly Forest Research Officer in the Federated Malay States, is now in Berkeley. He will remain for some months, and while here, will consult the University of California Herbarium and Library in connection with his researches upon the Dipterocarpaceae. Dr. Foxworthy has spent many years in the Philippines, Borneo, and other parts of the eastern tropics, where he has done extensive field work. He is the author of the following important papers dealing with the family: "Philippine Dipterocarpaceae" (Philipp. Journ. Sci. 6: no. 4, 231–287, pls. 34–44. 1911); "Dipterocarpaceae of the Malay Peninsula" (Malay Forest Records, no. 10, 1–289, pls. 1–23. 1932).

At a recent meeting of the California Academy of Sciences, San Francisco, Dr. Herbert L. Mason, Associate Curator of the Herbarium, University of California, Berkeley, gave an illustrated lecture on "The Origin of Forest Differentiation in California." The meeting was held in the assembly hall of the public library on the evening of March 6, 1935.

Dr. J. W. McKay of the Department of Botany, University of California, Berkeley, left the latter part of January of this year for Logan, Utah, where he has accepted a position in the Department of Botany of the State Agricultural College.

Mrs. Ynes Mexia left San Francisco on September 6, 1934, bound for Ecuador where she is now collecting plants used by the natives as fish poisons. These collections are being made under the direction of the Bureau of Plant Industry, United States Department of Agriculture. Having recently left Quito, she is now collecting at altitudes of from eleven thousand to twelve thousand feet in the little known mountainous region of eastern Ecuador.

Dr. David D. Keck of the Carnegie Institution Laboratory at Stanford University, California, left January first for the Atlantic states where, in connection with his research studies, he is visiting the principal herbaria and scientific institutions.

Dr. David R. Goddard, formerly of the Department of Botany, University of California, Berkeley, has accepted a position in Plant Physiology at the University of Rochester, New York.

Mr. Bassett Maguire of the Department of Botany, State Agricultural College at Logan, Utah, who is on leave during the present semester, has departed recently on a collecting expedition to the southwestern states and northern Mexico.

At the suggestion of Save the Redwoods League of California a botanical survey of Point Lobos State Park has been undertaken by Dr. H. L. Mason, Department of Botany, University of California, Berkeley. One set of the specimens collected will be kept in the University of California Herbarium as a permanent record of the plant population of the area.

The California Botanical Society announces a field trip and lecture for Saturday, April 6, 1935. The group will meet at 10:00 a.m. at the Physiology Building, Stanford University, and will proceed by automobile to Big Basin in the Santa Cruz Mountains. At 8:00 p.m. in Room 460, Physiology Building, Stanford University, Dr. Ira L. Wiggins, of the Department of Botany, will lecture on "Botanizing in Sonora."

For the last two weeks Lady Byng of Vimy, England, has been visiting the desert and middle western California under the guidance of Mrs. Lester Rowntree of Carmel Highlands. Monday, March 18, was spent in Berkeley, where Lady Byng was particularly interested in observing the development of the University of California Botanical Garden in Strawberry Canyon. She expressed herself as much pleased with the prospect of the ultimate establishment of a truly representative botanical garden in Berkeley, and appreciated the unique character of the site which has been set aside as the garden area. One of the most prominent amateur horticulturists in England, Lady Byng has recently been elected President of the British Alpine Garden Society. With real enthusiasm for the California flora she has successfully propagated a considerable number of those species which are adapted to the conditions in her Essex garden. She is a writer of novels as well as a garden enthusiast and has also been actively associated with her distinguished husband, Viscount Byng, in all of his many and varied activities. With Mrs. Rowntree, Lady Byng left on March 19 to extend her trip into Lake County.

Mr. A. E. Wieslander of the California Experiment Station and Mr. J. E. Adams of the Department of Botany, University of California, Berkeley, made a trip to San Diego County, California, during the latter part of February. Mr. Adams was interested in making field studies and collections of the genus Arctostaphylos. Especial attention was paid to the region about Mt. Otay which by the construction of a new road has recently become accessible.

Dr. Carl C. Epling of the Department of Botany of the University of California at Los Angeles recently made a three weeks' trip to Baja California, traversing the region from

Tijuana to Calmalli. The expedition was undertaken mainly for the purpose of field investigations upon Salvia and other Labiatae. Dr. George M. McBride of the Department of Geography of the same institution and several advanced students in botany accompanied Dr. Epling. The winter rains are said to have been the heaviest in twenty years and this region, usually semi-desert in aspect, was luxuriant with vegetation.

PROCEEDINGS OF THE CALIFORNIA BOTANICAL SOCIETY

Thursday, December 13, 1934. A meeting was held at 8:00 p.m. in Room 2093, Life Sciences Building, University of California, Berkeley. The President, Dr. George J. Peirce, occupied the chair. The report of the nominating committee, read by Mr. C. J. Kraebel, was as follows: President, Dr. George J. Peirce; First Vice President, Miss Alice Eastwood; Second Vice President, Professor Emanuel Fritz; Treasurer, Dr. David D. Keck; Secretary, Miss Ethel Crum. Professor D. R. Hoagland, Chairman of the Department of Botany, University of California, Berkeley, spoke on "Essential Mineral Elements and Plant Growth." Professor Hoagland summarized the results of recent research in this field. The slides which accompanied the lecture illustrated the effects of the presence or absence of certain minerals, especially boron and zinc, upon plant growth.

Thursday, January 24, 1935. A meeting was held at 8:00 p.m. in Room 2093, Life Sciences Building, University of California, Berkeley. The President, Dr. George J. Peirce, occupied the chair. The officers nominated at the December meeting were unanimously elected. Following the business meeting, Dr. Adriance S. Foster, Department of Botany, University of California, Berkeley, gave an illustrated lecture on "Morphology and Development of Leaves in Angiosperms." Dr. Foster emphasized certain aspects of leaf development in Aesculus and Carya.

Saturday, March 2, 1935. The annual dinner of the Society was held at International House, Berkeley, at 6:00 p.m. Dr. George J. Peirce, President, acted as toastmaster. Dr. G. P. Burns, visiting botanist from Vermont, responded to a toast from the President. A musical program, under the direction of Mr. W. W. Carruth, was presented by a trio of Mills College students. The speaker of the evening, Professor C. S. Hutchison, Dean of the College of Agriculture, University of California, Berkeley, discussed a timely subject, "The Future of the Soil: A Planned Agriculture." The lecture was followed by an animated discussion. Sixty-two members and guests attended the dinner and lecture.—E. Crum, Secretary.

NOTES ON WESTERN LEATHERWOOD, DIRCA OCCIDENTALIS GRAY

H. E. McMinn and Beatrice Forderhase

Western Leatherwood is one of two known species of the genus *Dirca.* This genus is one of about forty genera belonging to the Mezerium Family (Thymelaeaceae) which is composed largely of shrubs and trees widely distributed in the temperate and tropical zones. *Dirca,* like most of the other genera in this family, has rather a limited distribution, being found in only two widely separated regions in North America. One species, *Dirca palustris* L., grows in woods and along streams from New Brunswick westward to Minnesota and southward to Florida. The other species, *Dirca occidentalis* Gray (fig. 1), is a rare shrub inhabiting moist shady slopes in a few localities of the San Francisco Bay region of California. The known localities are in the Oakland, Berkeley, and San Leandro hills of Alameda and Contra Costa counties, in the foothills of the mountains west of Palo Alto in San Mateo and Santa Clara counties, and in Marin County (Lagunitas, *Mrs. A. M. Gilbert*).

Dirca occidentalis is an erect deciduous shrub, 2 to 8 feet high, with numerous ascending branches forming an inverted-pyramidal crown. The bark is smooth, leathery, and varies from gray to dark brown or almost black. The wood is soft but very tough and flexible. Branches as much as three-eighths inch in diameter can be tied into knots with ease. The leaves, appearing after the flowers, are simple, alternate, broadly elliptic or oval to obovate, 1 to 3 inches long, rounded at base and apex, entire, light green and glabrous above, paler and slightly pubescent beneath especially along the veins when young, and short-petioled. The flowers are pale yellow and are borne in outward and downward pointed clusters of two to four from small axillary and terminal buds which also bear the leaves. The bud-scales are densely white- or yellow-villous, inconspicuous until the buds begin to expand, and then they appear at the nodes as silvery hairy "domes." Each flower is composed of a tubular 4- (or rarely 5-) lobed corolla-like calyx about one-third inch long, 8 to 10 exserted stamens, and a single simple pistil with a sessile superior 1-ovuled ovary and a slender style longer than the stamens. The fruit is a semiglobular reddish drupe one-fourth to one-half inch long, but it rarely develops in any quantity. The blooming period occurs from January to March, varying with the seasons.

The flexible and leathery nature of the stems and branches can be partially accounted for by the number and peculiar arrangement of the xylem vessels (pl. III, fig. 1). In most genera

Madroño, vol. 3, pp. 117–148, July 1, 1935.

of angiospermous plants the vessels constitute a large proportion of the wood and are generally arranged in definite patterns of rows and masses. In the stem of western leatherwood the vessels occupy less than one-sixth of the wood and they are arranged in irregular C- or S-shaped bands scattered throughout the wood. The walls of the vessels are relatively thick and highly lignified, thus giving them great rigidity. Examination of the accompanying photomicrographs (pl. III, figs. 1, 2) shows that the bulk of the wood is composed of wood fibers arranged in definite radial rows. The walls of the wood fibers are lignified and relatively thin. This radial arrangement of cells is characteristic of all secondary tissue formed from the cambium, but in many instances it is soon altered by subsequent differentiation.

Fig. 1. Late winter branches of *Dirca occidentalis* with buds and flowers.

At the conclusion of each year's growth one or two rows of wood parenchyma can be distinguished by the slightly darker appearance of the cell walls. This arrangement of wood parenchyma is generally referred to as terminal. The walls of these cells are composed of cellulose and are rather thin. The only other elements of the wood are xylem ray cells which can be distinguished in the photomicrographs as narrow, radiating bands of cells elongated in the direction of the long axis of the rays.

In the opinion of the writers the great flexibility of the stems and branches would be accounted for by the C- or S-shaped arrangement of the narrow bands of xylem vessels, by the radial arrangement of the wood fiber cells and the thinness of their

Fig. 1. Cross section of 6-year-old stem of *Dirca occidentalis* showing C- or S-shaped arrangement of xylem vessels. Photomicrograph.

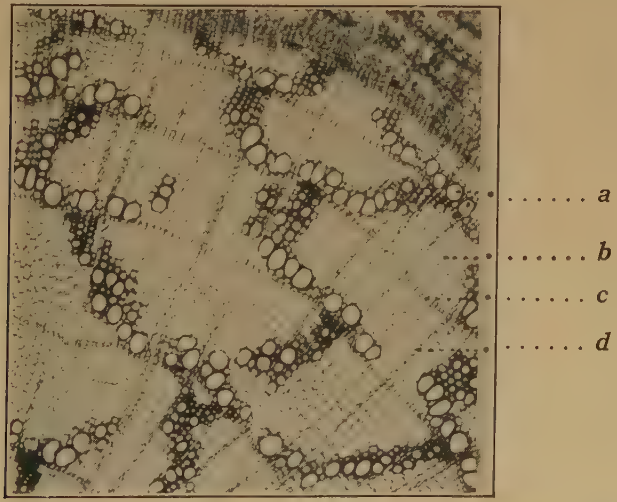

Fig. 2. Portion of the cross section of wood of *Dirca occidentalis: a,* xylem vessels; *b,* wood fibers; *c,* wood parenchyma; *d,* xylem ray. Enlarged photomicrograph.

PLATE III. DIRCA OCCIDENTALIS: STRUCTURE OF WOOD.

walls, and by the terminal position of the wood parenchyma cells and the thinness and cellulose nature of their walls.

The plants are very ornamental in their native habitat during late winter or early spring. The yellowish-green young foliage stands out in sharp contrast to the dark green foliage of the associated shrubs. Branches cut just as the silvery bud-scales are being pushed out by the expanding buds will continue to grow when placed in water until the flowers and leaves are completely developed. They make a unique and ornamental bouquet when other plant materials are not abundant.

Attempts at transplanting these shrubs into gardens have not been very successful. In nature they propagate by sending up new plants from underground stems which run parallel to the surface of the ground in the upper layer of loose soil which is usually covered by 3 to 6 inches of leaf mold. The roots penetrate the soil to great depths and it is difficult to find young plants without long roots or which are not connected to the parent plants.

The extremely limited distribution, the ornamental nature of the buds, flowers, and foliage, and the flexibility of the stems and branches make western leatherwood one of the most interesting of the California native shrubs.

Mills College, February, 1935.

THE WASHINGTON SPECIES AND VARIETIES OF ROSA

George Neville Jones

In 1906 Piper (6, pp. 334–335) recorded only three species of *Rosa* for Washington. In 1915, one additional species, an adventive, was included (7, pp. 204–205). In the present paper[1] an attempt is made to record some of the distinguishing characteristics and distributional facts concerning the four non-native and the five native species (Linneons) and their several varieties. Two new varieties are proposed. The geographical distribution of the different species and varieties in Washington is shown in figure 1. An attempt is made to correlate taxonomic characters with geographical distribution and to furnish a usable key for identification of the plants. The application of this taxonomic-geographic method has aided in the solution of several perplexing problems of identity and relationship and has also pointed to the probability that one of the best methods of solving such problems is to be found in a local study of a small number of species over a long period of time. During a six year study of Washington roses in the field and in the herbarium no direct evidence of hybridity has been noted. This

[1] Since this paper was written there has appeared an excellent summary of certain data concerning the North American Cinnamomeae, by Dr. E. W. Erlanson (2).

does not mean that hybridization does not occur in the genus *Rosa* under natural conditions in Washington but that if it does occur it is at least not frequent enough to cause taxonomic difficulty. Possibly this revision does not deal with all the species and varieties of the genus that occur in this state. If, and when, other species are found, they too will have to be included, and,

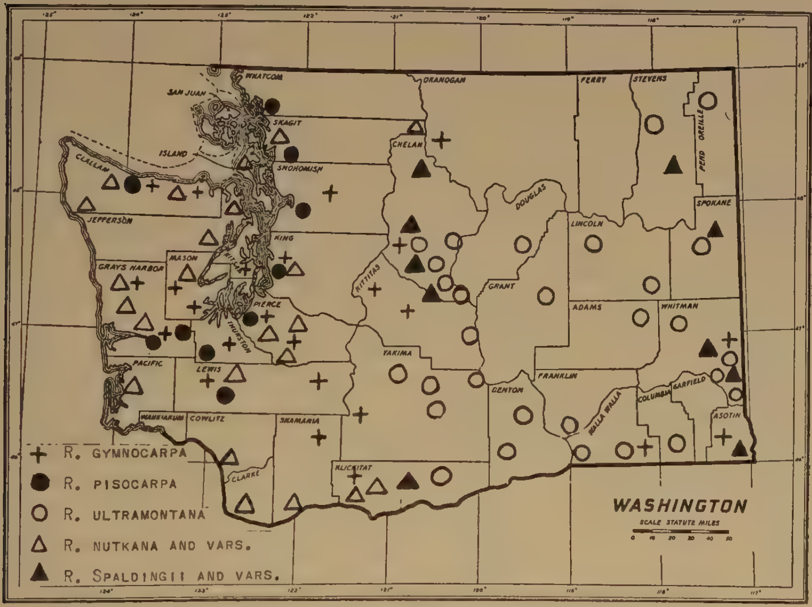

Fig. 1 Distribution of the native species of *Rosa* in Washington.

as Dr. L. H. Bailey remarks about another genus, "in the end we shall admit as many species as there are."

One cannot fail to be impressed with the appropriateness of Dr. Hultén's remark in his great work on the flora of Kamtchatka (4) concerning the genus *Rosa* in that region: "To judge from the literature on the subject the genus *Rosa* is very multiform and presents rather complicated conditions. . . . As a matter of fact, the conditions, when studied in nature, seem to be comparatively simple."

Thanks for the loan of specimens are due Professor John Davidson of the University of British Columbia, Dr. W. R. Maxon of the United States National Herbarium, Dr. E. D. Merrill and Dr. H. A. Gleason of the New York Botanical Garden, Mr. J. C. Nelson of Salem, Oregon, Dr. F. L. Pickett of the State College of Washington, and Mr. J. W. Thompson of Seattle. The majority of the specimens cited are in the herbaria of the University of Washington at Seattle and the State College of Washington at Pullman.

Key to the Species and Varieties

1. Prickles strongly curved or hooked; adventive or naturalized species.
  2. Stems trailing or climbing; flowers white; sepals reflexed, deciduous from the mature fruit; styles much exserted beyond the mouth of the hypanthium.
    3. Flowers 1.5–2 cm. broad, very fragrant, in many-flowered pyramidal corymbs; leaflets usually 9, simply serrate, with non-glandular teeth; stipules pectinate .... 1. *R. multiflora*
    3. Flowers 3–5 cm. broad, scentless, in few-flowered corymbs or commonly solitary; leaflets usually 7; stipules entire or denticulate .. 2. *R. arvensis*
  2. Stems erect or arching; flowers rose or pink, 1–4 together, 3–5 cm. broad; styles not exserted or only slightly so.
    3. Leaflets doubly serrate with gland-tipped teeth, pubescent or more or less glandular-pruinose beneath; sepals glandular-hispid on the back; pedicels usually glandular-hispid.
      4. Leaflets suborbicular to broadly oval, obtuse or acutish, pubescent and glandular beneath, fragrant; styles pubescent; sepals tardily deciduous from the mature fruit or sometimes long-persistent. .... 3. *R. rubiginosa*
      4. Leaflets ovate or oval, acute or short-acuminate, more or less pubescent on both sides, more or less glandular beneath; styles glabrous or nearly so; sepals soon deciduous from the mature fruit .... 3a. *R. rubiginosa* var. *micrantha*
    3. Leaflets simply and sharply serrate, glabrous on both sides, shining above, rarely slightly glandular on the midrib beneath, oval or ovate, acute; styles pubescent; sepals glabrous on the back, in fruit reflexed and tardily deciduous, two or more of them usually pinnately lobed .. 4. *R. canina*
1. Prickles straight or none, never strongly curved or hooked; stems erect, not or scarcely arching; foliage not noticeably sweet scented; native species.
  2. Sepals persistent on the mature fruit; pistils numerous.
    3. Flowers mostly corymbose, if solitary, the petals 10–18 mm. long; hypanthium in fruit small, rarely more than 1 cm. in diameter; teeth of the leaflets simple, non-glandular.
      4. Sepals more or less glandular on the back, often densely so, rarely eglandular, sometimes prickly; leaflets oval to ovate, rounded at the base, finely serrate (average number of teeth per leaflet 29); coastal species .... 5. *R. pisocarpa*
      4. Sepals eglandular or nearly so, glabrous or puberulent; leaflets obovate or oval, usually cuneate at the base, coarsely and sharply serrate (average number of teeth per leaflet 21); species of eastern Washington .... 6. *R. ultramontana*
    3. Flowers mostly solitary, rarely 2–4 together;

petals 2–4 cm. long; mature fruit large, 12–22 mm. in diameter.

4. Leaflets almost always doubly or triply serrate with gland-tipped teeth, more or less glandular-granuliferous beneath; stipules and rachises glandular; prickles large, stout, and more or less flattened at the base; coastal species.

   5. Hypanthium smooth.

      6. Leaflets not conspicuously glandular-muricate beneath; sepals glabrous or rarely glandular on the back; hypanthium in mature fruit 15–18 mm. in diameter . . . . 7. *R. nutkana*

      6. Leaflets conspicuously glandular-muricate beneath; sepals glandular-hispid on the back; hypanthium in mature fruit 12–15 mm. in diameter . . . . 7a. *R. nutkana* var. *muriculata*

   5. Hypanthium setose . . . . 7b. *R. nutkana* var. *setosa*

4. Leaflets coarsely and more or less regularly simple-toothed, the teeth not glandular, or very rarely so; blades of the leaflets more or less puberulent beneath, but not or rarely glandular-granuliferous or glandular-muricate; rachises and petioles not or only sparingly glandular; prickles smaller, not conspiculously flattened at base; species of eastern Washington.

   5. Floral branches slender, glabrous, often somewhat prickly; leaflets thin, less than 3 cm. wide; hypanthium in fruit red, 12–18 mm. in diameter; stems usually armed with straight, paired prickles.

      6. Stipules, petioles, rachises, and leaflets puberulent; flowers 3–5 cm. in diameter.

         7. Hypanthium smooth or nearly so. 8. *R. Spaldingii*

         7. Hypanthium more or less densely prickly . . . . 8a. *R. Spaldingii* var. *hispida*

      6. Stipules, petioles, rachises, and leaflets glabrous, non-glandular; flowers 5–8 cm. in diameter; floral branches unarmed; hypanthium smooth . . . . . . 8b. *R. Spaldingii* var. *alta*

   5. Floral branches stout, pubescent, unarmed; leaflets large, coarse, thick, 4–6 cm. long, 3–4 cm. wide, very coarsely crenate-serrate; hypanthium in fruit smooth, orange, 20–22 mm. in diameter; stems unarmed . . . . 8c. *R. Spaldingii* var. *chelanensis*

2. Sepals deciduous with the upper part of the hypanthium, eglandular; pistils few; leaflets doubly serrate with glandular teeth; flowers solitary, about 2 cm. in diameter; stems bristly and prickly . . . . 9. *R. gymnocarpa*

Section I. SYNSTYLAE. Stems climbing or trailing, with hooked or curved prickles; flowers corymbose; sepals pectinately lobed or serrate, soon deciduous; styles united into a column, much exserted.

1. ROSA MULTIFLORA Thunb.

Rosa multiflora Thunb. Fl. Jap. 214. 1874; Rydberg, Bull. Torr. Club 48: 160. 1921.

Distribution: no Washington specimens of this oriental species have been seen by the present writer but Rydberg (9, p. 160) reports it "as a ballast plant at one station in Washington." Type locality: near Nagasaki, Japan.

2. ROSA ARVENSIS Huds.

Rosa arvensis Huds. Fl. Angl. ed. 1, 192. 1762; Rydberg, Bull. Torr. Club 48: 160. 1921.

Distribution: reported to be "common in the vicinity of Vancouver, Clark County, Washington, apparently fully spontaneous" by Rydberg, who quotes Mr. J. C. Nelson of Salem, Oregon, as the authority for the statement. However, Mr. Nelson in a personal letter dated February 28, 1934, states that *Rosa arvensis* is unknown to him and that he is at a loss to know where Rydberg got the information. Rydberg gives the following citation: "WASHINGTON: Vancouver, *R. V. Bradshaw 1053*." According to Dr. H. A. Gleason this specimen is not to be found in the Herbarium of the New York Botanical Garden. Since this species is often cultivated and is inclined to spread from old gardens additional reports of its occurrence in Washington are to be expected. Type locality: England.

Section II. CANINAE. Stems erect or arching, usually with hooked or curved prickles; leaflets mostly 7; flowers corymbose; sepals often lobed, reflexed after anthesis and usually soon deciduous; styles distinct, not exserted.

3. ROSA RUBIGINOSA L. Sweetbriar. Eglantine.

Rosa Eglanteria L. Sp. Pl. 491. 1753.

Rosa rubiginosa L. Mant. Pl. 564. 1771; Howell, Fl. Nw. Am. 1: 170. 1898; Frye & Rigg, Nw. Fl. 220. 1912, Elem. Fl. Nw. 132. 1914; Henry, Fl. S. B. C. 174. 1915; Piper & Beattie, Fl. Nw. Coast 205. 1915; Rydberg, N. Am. Fl. 22: 494. 1918; Carter & Newcombe, Prel. Cat. Fl. Vanc. & Q. C. Is. 50. 1921; Rydberg, Bull. Torr. Club 48: 161. 1921; Gilkey, Spr. Fl. Nw. Ore. 67. 1929; Benson, Contr. Dudley Herb. 2: 97. 1930.

Distribution: common along roadsides and in fields in western Washington; occurs also in a few localities in eastern Washington; thoroughly established and very abundant in gravelly soil, especially along roads and fences, on the "prairies" near

Tacoma, appearing as if native. It is said to have spread originally from the Hudson's Bay Company's Fort Nisqually (the first home of white men on Puget Sound), the site of which is now occupied by the town of Dupont in Pierce County. The Sweetbriar is common also along the north bank of the Columbia River in Clark County. Type locality: European.

Specimens examined: Clark County: Vancouver, *Jones 4716.* Cowlitz County: Kalama, *Jones 6068.* Island County: Coupeville, *Jones 4843.* Mason County: Skokomish River, *Schwartz,* July 1932. Pierce County: Tacoma, *Jones* in 1933. Skagit County: Mount Erie, *Hardin,* April 25, 1926. Whatcom County: Bellingham, *Hardin,* June 2, 1925. Whitman County: Pampa, *St. John 9700;* Pullman, *Jones* in 1930.

According to A. H. Wolley-Dod (11) there is much doubt as to what Linnaeus meant by the older name *R. Eglanteria;* "specimens and notes in his herbarium show that he intended to apply it to *R. lutea* Mill., which is corroborated by his differentiating it, in the 'Mantissa,' from *R. rubiginosa* by its yellow flowers."

3a. Rosa rubiginosa var. micrantha (Borrer) Lindl.

Rosa rubiginosa var. *micrantha* Lindl. Rosarum Monogr. 87. 1820.

Rosa micrantha Borrer, Sm. Engl. Bot. pl. 2490. 1813; Rydberg, Bull. Torr. Club 48: 161. 1921.

Distribution: "naturalized in Oregon and Washington" according to Rydberg. No Washington specimens seen. Type locality: England, "probably near London."

4. Rosa canina L. Dog Rose.

Rosa canina L. Sp. Pl. 491. 1753; Rydberg, N. Am. Fl. 22: 495. 1918.

Distribution: known in Washington only from the following collection: along roadside near Kennedy Creek, Mason County, *Jones 3488.* Type locality: Europe.

Section III. Cinnamomeae. Stems erect, either unarmed or with usually straight infrastipular, often paired prickles; leaflets 5–11; flowers solitary or corymbose; sepals usually entire, persistent after anthesis; pistils numerous; styles not exserted, persistent, as is also the upper part of the hypanthium.

According to a recent work by Erlanson (1) the Washington roses of the Section *Cinnamomeae* may be placed in two cytological groups: the diploid group, including *R. pisocarpa,* with $2n = 14$, and the hexaploid group, including *R. nutkana,* and *R. Spaldingii,* with $2n = 42$. This arrangement coincides with current taxonomic treatments. The diploid group is characterized by having the flowers mostly corymbose, or if solitary, the petals 2 cm. long or less, and the hypanthium in fruit rarely more than

1 cm. in diameter. The hexaploid group has the flowers mostly solitary, the petals usually 2.5 cm. or more in length, and the hypanthium in fruit 12–22 mm. in thickness. In a later paper (2, p. 203) Dr. Erlanson states: "In my experience chromosome number has proved to be no more than another important diagnostic characteristic. Cytological studies have helped to clarify the situation, but have not seriously affected the classification of the genus as worked out by Crépin in the last century and by Boulenger on purely morphological lines more recently."

5. **Rosa pisocarpa** Gray. Bunch Rose.

Rosa pisocarpa Gray, Proc. Am. Acad. 8: 382. 1872; Howell, Fl. Nw. Am. 1: 169. 1898; Piper, Contr. U. S. Nat. Herb. 11: 335. 1906, as to w. Wash. specimens; Frye & Rigg, Nw. Fl. 221. 1912, Elem. Fl. Nw. 132. 1914; Henry, Fl. S. B. C. 174. 1915; Piper & Beattie, Fl. Nw. Coast 205. 1915; Rydberg, N. Am. Fl. 22: 522. 1918; Carter & Newcombe, Prel. Cat. Fl. Vanc. & Q. C. Is. 50. 1921; Jepson, Man. Fl. Pl. Calif. 499. 1925; Gilkey, Spr. Fl. Nw. Ore. 67. 1929; Benson, Contr. Dudley Herb. 2: 99. 1930.

Distribution: Humid Transition. British Columbia to California, west of the Cascade Mountains. Common at low elevations in western Washington, growing in thickets and swampy ground, often along the seashore. In eastern Washington it is replaced by *R. ultramontana*. Specimens without flowers or fruit can be readily distinguished from *R. nutkana* Presl, with which it frequently occurs, by the simple-toothed eglandular leaflets. The flowering period is from June 15 to July 20. Type locality: Multnomah County, Oregon. Collected by Elihu Hall.

Specimens examined: Grays Harbor County: Satsop, *Heller 4032;* McCleary, *Jones 4585.* King County: Seattle, *Piper,* September 1896; Kent, *Jones 896, 897, 900.* Snohomish County: Everett, *Jones 4895.* Thurston County: Grand Mound, *Jones 1422.* Kitsap County: Waterman, *Warren 94;* Orchard Point, *Piper,* July 1895.

6. **Rosa ultramontana** (Wats.) Heller. Canyon Rose.

Rosa californica var. *ultramontana* Wats.; Brew. & Wats. Bot. Calif. 1: 187. 1876.

Rosa ultramontana (Wats.) Heller, Muhlenbergia 1: 107. 1904; Rydberg, Fl. Rocky Mts. 444. 1917, N. Am. Fl. 22: 523. 1918; Standley, Contr. U. S. Nat. Herb. 22: 366. 1921; Tidestrom, Contr. U. S. Nat. Herb. 25: 282. 1925.

Rosa chrysocarpa Rydberg, Bull. Torr. Club 44: 74. 1917.

Distribution: Upper Sonoran and Arid Transition. British Columbia to California, east of the Cascade Mountains. A com-

mon plant in the canyons and river valleys of eastern Washington. The flowering period is from May 10 to July 5. Type locality: Eastern side of the Sierra Nevada (California).

Specimens examined: Benton County: Prosser, *Cotton 1093*, *Henderson*, May 26, 1892, *Bennett*, May 6, 1926, *Jones 398;* Rattlesnake Hills, *Cotton 469*. Chelan County: Chiwaukum, *Jones 4798, 4783;* Wenatchee, *Whited 677, 1125, 1334, Griffiths & Cotton 148;* Entiat, *Jones 1401;* Entiat Valley, *Morrill 241*. Columbia County: Blue Mountains, *Lake & Hull 819*. Grant County: Wilson Creek, *Sandberg & Leiberg 320*. Kittitas County: Cle Elum, *Henderson*, June 11, 1892, *Palmer 37859, Jones 4402, 4395, 4392;* Ellensburg, *Whited 677, 443, Jones 1406;* Easton, *Jones 4405;* Skookumchuck Creek, *Jones 1405*. Klickitat County: Klickitat Hills, *Jones 4472*. Lincoln County: Sprague, *Taylor 357;* Wilbur, *Henderson*, July 12, 1892. Pend Oreille County: Ione, *Sprague 372*. Spokane County: Spokane, *Jones 587;* Clarks Springs, *Kreager 47, Beattie & Chapman 2003*. Stevens County: Kettle Falls, *Sprague 363*. Walla Walla County: *Hill*, May 15, 1911; Wallula, *Cotton 1057*. Whitman County: Almota Creek, *St. John 9253;* Pullman, *Piper 1538, 1541, St. John 9274, Jones 1949, 1950, 1951, 1952, 1947, 1940, 2046, 2050, 2054, 2047, 2342;* Colfax, *Parker 591;* Rock Lake, *Weitman 163, Beattie & Lawrence 2425;* Indian, *St. John & Warren 3397;* Snake River Canyon, *Jones 2037;* Wawawai, *Henderson*, July 19, 1892; Kamiak Butte, *Jones 968, 969*. Yakima County: Yakima, *Henderson*, May 5, 1892, *Jones 1421;* North Yakima, *Steinweg* in 1894; Naches, *Jones 2222, 2223;* Soda Springs, *Jones 1420;* Satus Creek, *Jones 4422;* Tieton, *Warren 1833, 2074*. Without locality, *Vasey* in 1889.

Rosa Macounii Greene, and *R. Woodsii* Lindl., attributed to Benton County by St. John & Jones (10) are better referred to *R. ultramontana*.

Rosa chrysocarpa Rydberg appears to be merely a glabrous or nearly glabrous form of *R. ultramontana*. *Warren 1833* and *2074* from the Tieton River match the type of *R. chrysocarpa* perfectly.

Rosa ultramontana often occurs with *R. Spaldingii*. It can be readily distinguished in the field by the following characteristics: it begins to flower a week or two later; the flowers are smaller, corymbose, rose instead of pink; there is a large, foliaceous bract-like stipule at the base of the inflorescence; the leaflets are paler green, smaller, and narrower; the branches are more slender and with a tendency to be arching, and the bark of the young branches is somewhat glaucous.

7. Rosa nutkana Presl. Nutka Rose.

Rosa nutkana Presl, Epimel. Bot. 203. 1849; Howell, Fl. Nw. Am. 1: 168. 1898; Piper, Contr. U. S. Nat. Herb. 11: 334. 1906; Frye & Rigg, Nw. Fl. 221. 1912, Elem. Fl. Nw. 132. 1914; Henry, Fl. S. B. C. 175. 1915; Piper & Beattie, Fl. Nw.

Coast 205. 1915; Rydberg, Fl. Rocky Mts. 442. 1917, N. Am. Fl. 22: 511. 1918; Rydberg, Bull. Torr. Club 48: 165. 1921; Carter & Newcombe, Prel. Cat. Fl. Vanc. & Q. C. Is. 50. 1921; Jepson, Man. Fl. Pl. Calif. 498. 1925; Gilkey, Spr. Fl. Nw. Ore. 66. 1929; Benson, Contr. Dudley Herb. 2: 97. 1930.

Rosa columbiana Rydberg, Bull. Torr. Club 48: 166. 1921, in part.

Rosa nutkana Presl var. *pallida* Suksd. Werdenda 1: 23. 1927.

Distribution: Humid Transition. Alaska to northern California. In moist thickets and open woods, especially near the seashore, where it is a common plant along the borders of salt marshes. Common west of the Cascade Mountains. No typical specimens have been seen from eastern Washington. The flowering period is from May 15 to July 15. Type locality: Nootka Sound, British Columbia. Collected by Haenke in 1791.

Specimens examined: Clallam County: *Elmer 2519;* Quillayute Prairie, *Jones 3749, 3613;* Beaver Creek, *Jones 4545.* Grays Harbor County: Lake Quinault, *Conard 162;* Montesano, *Heller 3875;* Humptulips, *Jones 3763, 4582.* Island County: Whidbey Island, *Gardner,* June 1, 1897; Langley, *Grant 2020.* Jefferson County: Port Hadlock, *Jones 3099;* Duckabush River, *Jones 3088.* King County: Seattle, *Piper 81, Jones 903.* Kitsap County: Charleston, *Rigg,* December 14, 1907. Klickitat County: Falcon Valley, *Suksdorf 10244;* Bingen, *Suksdorf 10821.* Mason County: *Kincaid,* May 1892. Pierce County: Goat Mountains, *Allen 292;* Mount Rainier, *Warren 1549;* Roy, *Jones 4643.* San Juan County: Friday Harbor, *Beattie 3326, Pope,* 1904; Stuart Island, *Lawrence 414.* Skagit County: Skagit Pass, *Lake & Hull 770;* Anacortes, *Hardin,* October 1925.

It is extremely probable that the *R. cinnamomea* Borrer; Hook. (Fl. Bor. Am. 1: 200. 1833, not *R. cinnamomea* L., 1753) collected by Scouler in 1825 on the "shores of the Columbia, near its confluence with the sea" should be regarded as a synonym of *R. nutkana,* the common species of that region, rather than as a synonym of *R. Spaldingii* as listed by Rydberg (9, p. 512), since that species is not known to occur within two hundred miles of the region about the mouth of the Columbia River. After the description of *R. cinnamomea,* Hooker (*loc. cit.*) includes the following statement: "Mr. Borrer observes that the specimens resemble the European plant, except that the flower stalks bear setae." It seems probable, therefore, that Dr. Scouler's specimen was a bristly variety of *R. nutkana* (possibly var. *setosa*). It is also probable that it is the same as the plants included by Jepson (5, p. 498) as *R. nutkana* var. *hispida.*

7a. Rosa nutkana var. muriculata (Greene) comb. nov.

Rosa muriculata Greene, Leaflets 2: 263. 1912; Rydberg, N. Am. Fl. 22: 511. 1918, Bull. Torr. Club 48: 165. 1921.

Rosa nutkana var. *hispida* Henry, Fl. S. B. C. 175. 1915, not *Rosa nutkana* var. *hispida* Fernald.

Distribution: with the typical form of the species, occurring sporadically, but chiefly near the seashore. British Columbia to southern Oregon. Type locality: near Woodland, Cowlitz County, Washington. Collected by F. V. Coville in 1898, no. 705 (type in U. S. Nat. Herb. 380003).

This phase of *R. nutkana* is characterized by the densely glandular-muricate stipules, the petioles and rachises strongly glandular and more or less prickly, the thick leaflets conspicuously glandular-muricate beneath "with callous white points which at first bear a small pellucid gland, this deciduous," the flowers 2–3 together or solitary, the petals 2–2.5 cm. long, the sepals glandular-hispid on back, and the mature fruits 12–15 mm. in diameter, sometimes more or less sparsely hispid. Typical *R. nutkana* has the stipules glabrous at least on the upper surface, the petioles and rachises glandular-puberulent but rarely slightly pubescent beneath on the veins, the flowers usually solitary, rarely 2–4 together, the petals 2.5–3.5 cm. long, the sepals glabrous or rarely glandular on the back, and the mature fruits 15–18 mm. in diameter.

Specimens examined: Cowlitz County: Woodland, *Coville 705* (type). Island County: Langley, *Grant,* June 1923; Oak Harbor, *Jones 4872;* Coupeville, *Jones 4844, 4929, 4932;* Useless Bay, *Jones 4964.* Jefferson County: Port Hadlock, *Jones 3099.* King County: Seattle, *Hindshaw* in 1897. San Juan County: Friday Harbor, *Pope,* July 27, 1904, *Peck 12894, Jones 3040.* Snohomish County: Mukilteo, *Jones 4851.*

Through the courtesy of Professor Davidson of the University of British Columbia, it has been possible to examine the following British Columbian specimens, which represent var. *muriculata:* Elgin, *J. K. Henry,* August 13, 1913 (4 sheets); Vancouver, *Davidson,* July 15, 1911.

7b. Rosa nutkana var. setosa var. nov.

Differt a forma typica hypanthia et pedicelli setosi, foliola 1–1.5 cm. longa, caules 30–60 cm. alti.

Type from a grass-covered rocky point in Deception Pass State Park, north end of Whidbey Island, Washington, June 2, 1934, *Jones 4908.*

8. Rosa Spaldingii Crépin. Spalding Rose.

Rosa Spaldingii Crépin, Bull. Soc. Bot. Belg. 15: 42. 1876; Rydberg, Fl. Rocky Mts. 442. 1917, N. Am. Fl. 22: 512. 1918, Bull. Torr. Club 48: 165. 1921; Tidestrom, Contr. U. S. Nat. Herb. 25: 281. 1925.

Rosa nutkana Piper & Beattie, Fl. Se. Wash. 137. 1914, not *Rosa nutkana* Presl.

Rosa columbiana Rydberg, N. Am. Fl. 22: 514. 1918, in part.

Distribution: Arid Transition. British Columbia to Wyoming,

Utah, eastern Oregon, and eastern Washington. Common on hillsides and along creeks and rivers in eastern Washington, particularly in the southeastern part of the state where it is the common hexaploid rose of the region. The flowering period is from May 1 to July 5. Type locality: Clearwater, Idaho.

Specimens examined: Asotin County: Anatone, *Jones 462, 2860, Gessell,* May 16, 1926; Grand Ronde River, *St. John 4164.* Chelan County: Chiwaukum, *Piper 2547, Jones 4780, 4785, 4787, 4809;* Merritt, *Jones 4759;* Blewett Pass, *Jones 4819;* Cashmere, *Jones 4815;* Stehekin, *Griffiths & Cotton 222;* Wenatchee, *Whited 1268.* Columbia County: Blue Mountains, *Darlington 229.* Kittitas County: Roslyn, *Whited 464;* Teanaway Creek, *Thompson 9484;* Cle Elum, *Jones 4396.* Klickitat County: Carp Lake, *Jones 1417.* Skamania County: Underwood, *Beattie 3806.* Spokane County: Spokane, *Henderson* in 1893. Stevens County: Chewelah, *Sprague 367.* Whitman County: Colfax, *Parker 390;* Pullman, *Piper 1539, St. John 9275, Jones 1941, 1942, 1948, 2578, 2044, 2035, 1399, 1944, 2051, 1418.*

Occasionally this rose has a few stalked glands on the margins of the leaflets, but the dentition is almost always single, not double. Specimens which are anomalous in this respect may be distinguished at once from typical *R. nutkana* by the slender prickles and the non-glandular rachises.

An examination of the type specimen of *Rosa columbiana* Rydberg shows it to be perfectly good *R. Spaldingii.* In many of the species which have straight prickles, specimens may be found occasionally on which the prickles are more or less slightly curved. On *Sandberg, MacDougal & Heller 381* (the type of *R. columbiana*) there are eighteen observable prickles of which only the three lowest ones are curved, the remainder being straight. Hence there is very strong presumptive evidence for concluding that this curvature was produced in the process of pressing. Another specimen cited by Rydberg (9, p. 166), from Forest Grove, Oregon, collected by *F. E. Lloyd* in 1893, has been examined and proves to be *R. nutkana* Presl. Thus, Rydberg's *Rosa columbiana* is seen to consist of a mixture of *R. Spaldingii* and *R. nutkana,* the type belonging to the former species.

8a. Rosa Spaldingii var. hispida (Fern.) comb. nov.

Rosa nutkana var. *hispida* Fernald, Bot. Gaz. 19: 335. 1894.

Rosa MacDougali Holz. Bot. Gaz. 21: 36. 1896; Frye & Rigg, Nw. Fl. 220. 1912, Elem. Fl. Nw. 132. 1914; Rydberg, Fl. Rocky Mts. 442. 1917, N. Am. Fl. 22: 510. 1918, Bull. Torr. Club 48: 164. 1921; Tidestrom, Contr. U. S. Nat. Herb. 25: 281. 1925.

Rosa nutkana MacDougali (Holz.) Piper, Contr. U. S. Nat. Herb. 11: 335. 1906; Piper & Beattie, Fl. Se. Wash. 137. 1914.

Distribution: Arid Transition. British Columbia to Montana and northern Utah. Hillsides, roadsides, and along streams chiefly in southeastern Washington. The flowering period is from May 30 to July 5. Type localities: Rock Creek, Montana, and Pullman, Washington.

Specimens examined: Stevens County: Cooney Mountains, *Large 95*. Whitman County: Pullman, *Piper 1540* (type), also September 9, 1894; Palouse, *Jones 650;* Colfax, *Parker 591a;* Kamiak Butte, *Jones 2577*.

One of the most interesting of the local roses is the one which is passing under the name of *R. MacDougali* Holz., a plant which was first designated by Fernald as *R. nutkana* var. *hispida* and later by Piper as *R. nutkana* subsp. *MacDougali.* This appellation was used by Piper because Fernald's name was antedated by the *R. hispida* of Moench in 1770. Fernald described this prickly fruited rose from specimens from Rock Creek, Montana, collected by Sereno Watson, July 27, 1880 (no. 124), and from Pullman specimens collected by C. V. Piper, June and September, 1893 (no. 1540). Duplicates of the Pullman specimens have been examined in the herbaria of the State College of Washington at Pullman, and in the University of Washington at Seattle. Fernald described these plants as follows: "A form of *R. nutkana* made conspicuous by its strongly glandular hispid receptacle and glandular calyx, though not otherwise differing from the type." In 1895 specimens of this spiny fruited rose collected by Sandberg & Leiberg in "canyons near Farmington Landing, south end of Lake Coeur d'Alene (Idaho); July 7, (no. 572)" were described by J. M. Holzinger (3, p. 223) as follows: "Distinguished at once from all other North American roses by the densely spiny fruits, and the stem with few epidermal spines, or frequently with none. Infrastipular thorns none; flowers solitary at the ends of short, leafy branches. Leaves and size of flowers as in *R. lucida.*" It should be noted here, however, that occasional specimens from Kamiak Butte, Whitman County, Washington, possess abundant infrastipular prickles.

Prior to the publication of Rydberg's comprehensive monograph in 1918 (8) the large-fruited rose of eastern Washington was considered to be *R. nutkana.* However, since 1918 it has been possible to re-evaluate the local species and we find that the common hexaploid rose of eastern Washington is not *R. nutkana* but *R. Spaldingii,* and therefore the specimens designated by Fernald as *R. nutkana* var. *hispida* belong, obviously, to the latter species, and are to be distinguished by no other character than the more or less glandular-hispid hypanthium. Furthermore, since *R. nutkana,* in its typical form at least, is not known to occur within several hundred miles of the known range of the prickly fruited plant under consideration, it seems to be somewhat illogical to consider the latter to be a mere variation of it.

Rather, the prickly fruited plant had better be regarded as a variety of *R. Spaldingii*. This conclusion is corroborated by the fact that intergrades between prickly fruited and smooth fruited plants of *R. Spaldingii* are found to occur within the range of that species (fig. 2).

Fig. 2. *Rosa Spaldingii, 1; Rosa Spaldingii* var. *hispida, 2, 3, 4.*

Jepson (5, p. 498) includes *R. nutkana* var. *hispida* Fernald describing it as follows: "Calyx-tube with gland tipped bristles." He states that this variety has been collected at Eureka, California. It may well be that there is a hispid form of *R. nutkana* in California, but it cannot be properly called by Fernald's name, which, as has been noted above, should be applied to the prickly form of *R. Spaldingii.*

8b. Rosa Spaldingii var. **alta** (Suksd.) comb. nov.
Large-flowered Rose.

Rosa nutkana Presl var. *alta* Suksd. Werdenda 1: 23. 1927.
Rosa megalantha G. N. Jones, Proc. Biol. Soc. Wash. 41: 194. 1928.

Distribution: Arid Transition. Type locality: Bingen, Washington.

Specimens examined: Chelan County: Entiat Valley, *Morrill 275.* Klickitat County: Bingen, *Suksdorf 10821* (type). Spokane County: Spokane, *Jones 614* (type of *R. megalantha*).

8c. Rosa Spaldingii var. chelanensis var. nov. Chelan Rose.

Caulibus inermibus erectis 1.5–2.5 m. altis glanduloso-granuliferis, ramis florentibus inermibus, stipulis dilatatis adnatis 1.5–3 cm. longis plus minusve glanduloso-denticulatis, petiolis rachidibusque velutinus, foliolis 7 ovalibus argute serratis supra glabris subtus sparse pilosis 3–5 cm. longis 1.5–3 cm. latis, floribus ignotis, pedicellis 2–4 cm. longis plus minusve velutinis vel glabratis, fructibus globosis 18–20 mm. diametro sine collo, seminibus in partis inferioribus lateralibusque affixis oblongis ca. 5 mm. longis et 3 mm. latis glabris, sepalis velutinis lanceolatis caudato-appendiculatis sub anthesin divergentibus vel reflexis persistentibus laminis 10–15 mm. longis appendiculo 10–15 mm. longo.

Type locality: in thickets along the Wenatchee River, near Cashmere, Chelan County, Washington, August 23, 1927, *Jones 1402*. A robust plant of very distinctive appearance; not seen in flower, but probably closely related to *R. Spaldingii* Crépin, from which it may be distinguished as follows:

R. Spaldingii	var. *chelanensis*
Stems usually armed with straight, paired prickles.	Stems unarmed.
Floral branches slender, glabrous.	Floral branches stout, glandular-granuliferous.
Hypanthium in fruit red, 12–18 mm. in diameter.	Hypanthium in fruit orange, 20–22 mm. in diameter.
Sepals erect, glabrous or very rarely glandular on the back, not velutinous.	Sepals spreading or reflexed, velutinous on the back.
Leaflets smaller, thinner, less than 3 cm. wide, less coarsely serrate, the teeth more acute.	Leaflets large, thick, 4–6 cm. long, 3–4 cm. wide, very coarsely crenate-serrate.

Section IV. Gymnocarpae. Stems erect, slender with numerous bristles and straight infrastipular spines; leaflets 5–7, usually doubly serrate; flowers solitary or few; pistils few; styles, sepals, and the upper part of the hypanthium deciduous.

9. Rosa gymnocarpa Nutt. Sylvan Rose.

Rosa gymnocarpa Nutt.; T. & G. Fl. N. Am. 1: 461. 1840; Howell, Fl. Nw. Am. 1: 169. 1898; Piper, Contr. U. S. Nat. Herb. 11: 334. 1906; Frye & Rigg, Nw. Fl. 220. 1912; Piper & Beattie, Fl. Se. Wash. 137. 1914; Frye & Rigg, Elem. Fl. Nw. 132. 1914; Henry, Fl. S. B. C. 174. 1915; Piper & Beattie, Fl. Nw. Coast 205. 1915; Rydberg, Fl. Rocky Mts. 445. 1917, N. Am. Fl. 22: 631. 1918, Bull. Torr. Club 48: 169. 1921; Carter & Newcombe, Prel. Cat. Fl. Vanc. & Q. C. Is. 50. 1921; Standley, Contr. U. S. Nat. Herb. 22: 365. 1921;

Jepson, Man. Fl. Pl. Calif. 449. 1925; Tidestrom, Contr. U. S. Nat. Herb. 25: 282. 1925; Gilkey, Spr. Fl. Nw. Ore. 67. 1929; Benson, Contr. Dudley Herb. 2: 100. 1930 (contains comprehensive synonomy).

Distribution: Transition and Canadian. British Columbia to Montana and California. In dry woods, common throughout the state, except in the sagebrush area and on the higher mountains. It is the only local species in the genus that is "shade-tolerant." It may be found in flower from May 15 to August 10. Type locality: "Oregon, in shady woods, common, *Nuttall! Douglas!*"

Specimens examined: Asotin County: Blue Mountains, *Jones 985;* Anatone, *Jones 463.* Chelan County: Chiwaukum, *Piper 2510, Jones 4789;* Merritt, *Jones 4761.* Columbia County: Wildcat Springs, *St. John 8314;* Blue Mountains, *Darlington 140, 218.* Clallam County: Port Crescent, *Lawrence 245, 226;* Sequim, *Grant 210, Elmer 2515.* Grays Harbor County: Quinault, *Conard 194;* Montesano, *Heller 3897.* Island County: Langley, *Grant* in 1923. King County: Seattle, *Piper 82, Meany* in 1885. Kitsap County: Charleston, *Rigg* in 1907. Kittitas County: Kashess Lake, *Jones 1415;* Cle Elum, *Henderson* in 1892. Klickitat County: Trout Lake, *Pearson 298.* Lewis County: Centralia, *Owen,* June 16, 1928. Mason County: New Kamilche, *Beattie 3678;* Mt. Ellinor, *Jennie V. Getty* in 1902. Okanogan County: War Creek, *St. John 3699.* Pierce County: Camp Lewis, *Davison,* July 4, 1925; Mt. Rainier, *Allen 72.* San Juan County: Friday Harbor, *Beattie 3331.* Snohomish County: Silverton, *Mrs. L. A. Bouck 60.* Skagit County: Cypress Island, *Hardin,* May 15, 1925. Thurston County: Chambers Prairie, *Henderson,* August 23, 1892. Walla Walla County: Blue Mountains, *Piper,* August 2, 1896. Whitman County: Kamiak Butte, *Piper,* July 20, 1899. Without locality, *Vasey* in 1889.

Excluded Species

Rosa anacantha Greene, Leaflets 2: 265. 1912. The type was collected in 1889 in thickets near the salt marshes near Tacoma. It is said to have crenate leaflets and "wholly unarmed" stems. It may be one of those not altogether rare species which was, to use M. L. Fernald's apt phrase, "exterminated by its discoverer."

Rosa collaris Rydberg, Fl. Rocky Mts. 441. 1917. According to the appearance of the type specimen this is a rather distinctive species, but until undoubted specimens are collected in Washington it cannot be admitted as a member of the flora of this state.

Rosa Fendleri Crépin, Bull. Soc. Bot. Belg. 15: 91. 1876. The following note appears on page 335 of Piper's "Flora of Washington": "The typical form of this species [*i.e., Rosa piso-*

carpa] occurs west of the Cascade Mountains. The eastern Washington forms are very variable as to leaf and fruit and consist, perhaps, of two species. Specimens have frequently been referred to as *Rosa fendleri* Crépin, but it is not at all clear how this is to be distinguished." *R. Fendleri* ranges from Minnesota to British Columbia and southward to Arizona and Mexico, but it is not known to occur in Washington.

University of Washington, Seattle,
February 18, 1935.

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NOTES ON THE GERMINATION OF CEANOTHUS SEEDS

Clarence R. Quick

The writer became interested in the seed germination of native California shrubs through work on *Ribes* seed germination in the Office of Blister Rust Control, United States Department of Agriculture. The object of the experiments reported below was to determine and define a satisfactory experimental method of forcing the germination of *Ceanothus* seeds.

In 1931 seeds of *Ceanothus cordulatus* Kell. and *C. integerrimus* H. & A. were collected by the writer in the Stanislaus National Forest. Preliminary tests showed that the planting of untreated seeds of these species was futile. Martin[1] has reported that the morphological structure which caused seed coats of *Melilotus alba* Desr. to be impermeable was rapidly hydrated in

[1] Abstr. in Proc. Iowa Acad. Sci. 29: 345–346. 1922.

water at 80° C. and became permeable. Hot-water treatment held promise for *Ceanothus* seeds, but tests showed that hot water alone was not satisfactory for some species. Many kinds of seeds have an embryo dormancy which can be removed by stratification (moist storage at low temperatures).[2] The combination of a hot-water treatment with stratification in moist sand at low temperatures was indicated. Good germination of *C. cordulatus* and *C. integerrimus* was accordingly obtained after boiling seeds for five minutes and then stratifying them for three or four months at about 2.5° C. (36° F.).

Seeds. In the fall of 1933 seeds of a number of species of *Ceanothus* were obtained, and the experiment to be reported was started. A list of the seed samples used in the work is given at the end of this paper.

Methods. Five different hot-water treatments were used. (1) The seeds were counted, tied in small cheesecloth bags, weighted so that they would sink, and boiled vigorously in water for one minute. (2) The seeds were treated as in number one above, but were boiled five minutes. (3) The seeds were tied in bags as before, suspended in four liters of water at 90° C. (194° F.) contained in an enamel-ware kettle, and allowed to cool to room temperature. The seeds were then removed and planted. (4) The seeds were suspended in four liters of water at 80° C. (176° F.) contained in a small uncovered sheet-metal pail and allowed to cool to room temperature. (5) The seeds were treated in four liters of water, as in number three above, but were cooled from 70° C. (158° F.).

Two sample lots of each of the species tested were subjected to each of the five hot-water treatments. One lot was planted and placed immediately in the greenhouse. The other was planted, placed in refrigeration, watered as necessary, and, after three or three and a half months, was removed to the greenhouse for germination test. Two controls of each species, one culture stratified and another not, were tested in addition to the cultures treated with hot water.

Unless stated otherwise the seeds were planted in germination flats at a depth of about 0.6 cm. in a medium of one half river sand and one half forest loam. In most cases each culture was contained within the flat in a separate compartment made by strips of paraffined cardboard set edgewise in the flat.

Germination in the unstratified cultures was checked for

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[2] There has been a great deal of experimentation on this problem. The six articles cited below offer access to the extensive literature on the subject: Bot. Gaz. 67: 281–308. 1919; Proc. Iowa Acad. Sci. 29: 257–266. 1922; Amer. Journ. Bot. 15: 625–626. 1928; Contr. Boyce Thompson Inst. 3: 385–404. 1931; Journ. Forestry 30: 925–928. 1932; Contr. Boyce Thompson Inst. 6: 323–338. 1934.

sixteen to twenty-four weeks; in the stratified cultures for three to eight weeks after removal to the greenhouse.

The two sets of sample lots boiled for five minutes, and the two sets receiving no hot-water treatment were planted on November 23 and 24, 1933. The stratified cultures of these sets were removed from refrigeration to the greenhouse on February 16, 1934. The seeds cooled from 90° C. to room temperature were treated on January 1, 1934. The flat of stratified cultures of this treatment was placed in the greenhouse on March 30, 1934. Due to remodelling of the 2.5° C. refrigeration room, the flat had been in a 5° C. room from February 16 to March 30. This may have slowed down the changes which take place in seeds stratified at temperatures slightly above 0° C. (32° F.). The seeds cooled from 80° C. and tested immediately for germination were treated on May 5, 1934. Those cooled from 80° C. and stratified were treated on June 18, 1934, and planted, but remained in refrigeration until September 24. The seeds boiled for one minute, and those cooled from 70° C. to room temperature were treated on December 31, 1934. The stratified cultures of these two series were removed to the greenhouse on March 25, 1935.

All the flats were treated with an aqueous suspension of cupric oxalate to reduce fungous injury to seeds and to prevent the damping-off of seedlings.

Results and discussion. Table I records the percentage germination which was obtained in the various cultures. To increase readability of the table the higher germination percentages have been printed with bold-faced type. The species have been divided roughly into four habitat groups, varying from a group of species of the high forested inland mountains to those species growing in close proximity to the sea. Obviously the species within any one group are not strictly comparable as to habitat.

From the table it is apparent that a hot-water treatment is desirable in the case of most of the species. It is also apparent that stratification after hot-water treatment increases the germination percentage of many species. In other words, the seeds have coats impermeable to water, and have varying degrees of embryo dormancy as well. This embryo dormancy and need of after-ripening by stratification is marked in the high montane species, and slight or lacking in the maritime species. The other two groups are intermediate; the montane group appears to respond more to stratification than the coastal group.

With certain exceptions the boiling of *Ceanothus* seeds for five minutes appears to be too severe a hot-water treatment. In general, the 70° and the 80° treatments were the most successful in overcoming without injury the delay in germination due to seed coat hindrance. A slightly less severe treatment, for instance a 60° series, might have been more successful on some of the seed collections.

No apparent relation was found between germinative response and taxonomic relationship.

The speed of germination (rate of seedling appearance) in stratified cultures was much greater than in unstratified cultures. As an example, new seedlings were occasionally appearing in the flat of 80° unstratified cultures six months after they were placed in the greenhouse, while only one seedling appeared in the 80° stratified cultures after the second week in the greenhouse. This rapid, or simultaneous, germination is highly desirable where the seedlings are to be used in experiments, as all the seedlings are then of approximately the same age.

Barton[3] has shown that the impermeable seed coats of *Tilia americana* L. can be made permeable by four months' moist storage at 20° C. in soil or peat moss. If a similar effect on the coats of *Ceanothus* seeds takes place, the slow but long-continued germination of unstratified cultures is readily explained in any of those species not requiring stratification.

Explanation of the Table

All germination figures over 50 per cent are printed in bold-faced type. The numbers at the top of columns are explained as follows:

1. Habitat groups of species: A. Species of the higher interior (forested) mountains. B. Species of the lower interior (chaparral-covered) mountains. C. Species from the low coastal (mostly fog-belt) hills. D. Species from very close to the ocean.
2. A germination period of six weeks, instead of the usual two weeks.
3. Medium was river sand. A germination period of three weeks instead of the usual two weeks. The rate of seedling emergence appeared to be slower in sand than in half sand and half loam.
4. Stratification period three and a half months, instead of the usual three months.
5. Stratified at 2.5° C. for one and a half months, and then at 5° C. for one and a half months.

List of Seed Samples

Each seed collection used in the experiment was: (1) collected in the field by the writer; or (2) furnished by the California Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, through the courtesy of Mr. C. J. Kraebel; or (3) purchased from Lester Rowntree and Co., Carmel, California; or (4) purchased from Aggeler and Musser Seed Co., Los Angeles. In the seed list these sources have been abbreviated to: (1) Quick, (2) C.F.E.S., (3) Rowntree, and (4) A. & M. Seed Co.

The order of data in the list below is as follows: species; seed year; source of seed; approximate elevation of collection; collection notes. 1. *C. arboreus* Greene. 1931. Rowntree. 500 feet. Santa Cruz Island, Santa Barbara Channel Islands. 2. *C. austromontanus* Abrams. 1932. Rowntree. 3,000 feet. Cuyamaca Mt., San Diego County. The type collection was made in coniferous forests. 3. *C. cordulatus* Kell. 1931. Quick. 5,000 feet. South Fork of Stanislaus River, Tuolumne County. 4. *C. crassifolius* Torr. 1932. C.F.E.S. 2,800 feet. Barranca Burn, Devil Canyon, San Bernardino National Forest, Lot No. 739. 5. *C. cuneatus* (Hook.) Nutt. 1932. C.F.E.S. 2,500 feet. Kendall Drive, San Bernardino, California. Lot No. 737. 6. *C. cyaneus*

[3] Contr. Boyce Thompson Inst. 6: 69–89. 1934.

TABLE I

GERMINATION OF CEANOTHUS SEEDS. EFFECTS OF PLANT HABITAT, HOT WATER, AND STRATIFICATION ON PERCENTAGE GERMINATION.

Habitat group[1]	Seed collection No.	Ceanothus species	Usual number of seeds per culture	Seed year	Seeds not stratified (not stored moist at low temperature) after hot-water treatment. Germination period of 16 weeks in greenhouse. Hot-water treatments as given below.						Seeds stratified (stored in moist cultures) at 2½° C. for 3 months after hot-water treatment. Germination test of 2 weeks in greenhouse. Hot-water treatments as given below.					
					No hot water	Boiled one min.	Boiled 5 min.	70° C. to cool	80° C. to cool	90° C. to cool	No hot water[2]	Boiled one min.[3]	Boiled 5 min.	70° C. to cool[3]	80° C. to cool[4]	90° C. to cool[5]
A	2	*C. austromontanus*	40	1932	0	0	0	0	0	0	3	8	0	64	48	13
A	3	*C. cordulatus*	40	1931	3	15	0	10	5	0	5	60	53	50	65	13
A	11	*C. integerrimus*	25	1931	0	0	0	0	0	—	0	68	28	44	85	—
A	19	*C. velutinus*	40	1932	0	5	10	5	3	20	3	30	63	25	68	25
B	4	*C. crassifolius*	25	1932	16	40	28	48	13	24	12	56	52	76	50	48
B	5	*C. cuneatus*	25	1932	4	48	8	60	24	23	0	32	4	92	56	23
B	8	*C. divaricatus*	40	1933	3	36	15	33	35	43	0	48	20	67	45	8
B	13	*C. purpureus*	40	1932	3	30	13	53	20	8	0	35	0	28	35	8
B	15	*C. sorediatus*	40	1930	0	—	38	—	—	—	0	—	100	—	—	—
C	6	*C. cyaneus*	40	1933?	—	60	—	65	53	35	—	10	—	35	60	35
C	9	*C. foliosus*	40	1932	28	65	18	77	20	28	33	56	0	92	50	28
C	10	*C. incanus*	40	1931	3	33	5	15	—	25	3	46	0	51	70	43
C	12	*C. papillosus*	40	1933	0	0	18	0	3	5	3	23	3	39	75	50
C	14	*C. rigidus*	40	1930	13	75	3	92	48	15	8	29	0	33	15	8
C	16	*C. spinosus*	20	1933?	5	—	100	—	—	—	5	—	65	—	—	—
C	17	*C. spinosus*	40	1933	3	88	0	100	84	—	0	44	0	88	96	—
C	18	*C. thyrsiflorus*	40	1933	0	68	50	73	45	55	0	63	28	83	55	45
D	1	*C arboreus*	33	1931	4	—	24	—	61	90	20	—	0	—	—	20
D	7	*C. dentatus*	40	1932	10	43	0	60	38	30	28	40	0	83	60	18
D	20	*C. verrucosus*	10	1932	20	—	0	—	—	—	5	—	0	—	—	—
A		Average of 4 species			1	5	3	4	2	7	3	42	36	46	67	13
B		Average of 5 species			5	39	20	49	23	25	2	43	35	66	47	22
C		Average of 7 species			8	56	28	60	42	27	8	39	14	60	61	35
D		Average of 3 species			11	—	8	—	50	60	18	—	0	—	—	19

Eastw. 1933. A. & M. Seed Co. No data on collection. The species is related to *C. thyrsiflorus* Esch. The original collection was made at Lakeside, San Diego Co., at an elevation of 1,500 feet. 7. *C. dentatus* T. & G. 1932. Rowntree. 20 feet. Coastal plain just north of Monterey, near town of Marina. 8. *C. divaricatus* Nutt. 1933. C.F.E.S. 2,500 feet. Trail to Panorama, Devil Canyon Forest Experiment Station, San Bernardino National Forest. 9. *C. foliosus* Parry. 1932. Rowntree. 1,500 feet. Seed produced on plant at Carmel, transplanted from near Mt. Tamalpais, Marin Co. 10. *C. incanus* T. & G. 1931. Rowntree. 500 feet. Bear Creek Road, Santa Cruz Mts., just east of (town of) Boulder Creek. 11. *C. integerrimus* H. & A. 1931. Quick. 4,800 feet. River flat with other species of "hard-chaparral," South Fork of Stanislaus River, Tuolumne County. 12. *C. papillosus* T. & G. 1933. Rowntree. 250 feet. About five miles south of Santa Cruz, on road to Watsonville. 13. *C. purpureus* Jepson. 1932. Rowntree. 2,000 feet. Napa Range, east of Napa. 14. *C. rigidus* Nutt. 1930. Rowntree. 500 feet. Carmel Highlands, four miles south of Carmel on Coast Road. 15. *C. sorediatus* H. & A. 1930. Rowntree. 1,000 feet. Napa Range, five miles northeast of Napa, on road to Monticello. 16. *C. spinosus* Nutt. Sample II. 1933? A. & M. Seed Co. Collection data not known. See next. 17. *C. spinosus* Nutt. Sample I. 1933. Quick. 250 feet. University of California Campus at Berkeley. Horticultural. 18. *C. thyrsiflorus* Esch. 1933. Quick. 750 feet. John Garber Park, Berkeley Hills. 19. *C. velutinus* Dougl. 1932. Rowntree. 6,000 feet. East side of Sonora Pass in Sierras. 20. *C. verrucosus* Nutt. 1932. Rowntree. 250 feet. Point Loma, San Diego County.

Bureau of Entomology and Plant Quarantine,
U. S. Department of Agriculture, April, 1935.

A VEGETATION TYPE MAP OF CALIFORNIA

A. E. Wieslander

Those interested in the California flora will be glad to know that published units of a vegetation type map of California will soon be available for distribution. This map is being prepared as a part of a forest survey of California conducted by the United States Forest Service in cooperation with other federal and various state and county agencies. The survey embraces a total area of nearly seventy million acres and will cover the entire state exclusive of the deserts and the larger valleys devoted mainly to agriculture. When complete there will be a total of 220 map units. These units consist of the standard United States Geological Survey 15 and 30 minute topographic sheets upon which the vegetation types are shown in color and symbol legend. To date, field work has been completed on forty-eight units of which eight are now off the press and fourteen additional are in the process of publication.

The vegetation types are mapped in the field directly upon Geological Survey topographic quadrangles by direct observation and sketching from ridges, peaks, and other vantage points, supplemented by frequent sample-plot checks. The major types which are shown by color legend are further subdivided into pure and mixed stands in which species composition is indicated by symbols. A pure stand is defined as one in which a single species forms more than 80 per cent of the vegetation cover;

while a mixed stand is one in which neither of the two or more species composing it exceeds 80 per cent.

On the map, a pure stand is designated by the single important dominant. Ordinarily a mixed stand is designated by those dominants individually forming 20 per cent or more of the cover and they are listed in so far as practicable in order of relative abundance. However, in a composite formation, which is neither distinctly herbaceous, shrubby, nor arborescent, but a mosaic of two or more of these elements, this percentage is applied to each class of vegetation separately. For example, in a tree-shrub formation, the tree and shrub species forming 20 per cent or more of the aggregate area occupied respectively by trees and shrubs are designated, prior place in the designation being given to the trees. In this classification understory vegetation is not considered, but only those elements of vegetation cover visible from above as from an airplane. In shrub types, an estimate is made of the percentage of cover formed by the various species, but in tree types it is frequently easier to approximate this by tree counts. These percentages serve more accurately as guides for the major types and for pure subtypes which stand out in fairly bold relief, than for mixed stand subtypes. Where the latter merge from one subtype to another so gradually that there are no visible dividing lines, the sample plots serve as a basis for a delineation which gives at least close altitudinal and slope exposure relationships.

Each of the major types or plant associations represents an attempt to group subtypes having fairly similar fire hazard characteristics, and uses or qualities of economic importance. Thus, these broad plant associations in color legend serve to make the maps of ready use to engineers, foresters, and others charged with the management of so-called wild lands, while the more detailed subtype units provide the basic information on vegetation cover desired by the research worker in various fields such as botany, ecology, and forestry.

A great wealth of material in addition to the vegetation type map itself is being procured in this survey. Sample plots cross-sectioning all types mapped supply such details as species composition, stand density, size of trees and shrubs, and depth of leaf litter. On a supplementary map such information is shown as (1) occurrence of tree species not abundant enough or too restricted in area to be designated on the type map; (2) occurrence of shrub species of especial importance, the range of which would otherwise not be indicated either by the type map or the sample plots; and (3) visible boundaries of burned-over areas. Herbarium specimens are collected from every species recorded upon the map or in the sample plots of each quadrangle mapped. Photographs illustrative of various vegetation conditions are taken and are so referenced that they may be duplicated at a later time for the purpose of recording vegetational changes.

The Vegetation Type Map Herbarium, housed on the fifth floor of the University Herbarium in the Life Sciences Building, University of California, Berkeley, should be of increasing interest to California botanists. This collection now contains about 7,500 mounted specimens and it is expected that between 3,000 and 4,000 will be added yearly. It includes many plants in addition to those required for authenticating the maps and sample plots. Very complete field notes accompany each specimen, comprising information as to collector, date, elevation, location, also notes as to size and character of the plant, the slope exposure, the formation in which it grows, and the names of the more common associated species.

The primary purpose of the herbarium is to serve as a check upon field identifications, and to afford a permanent record of the plants collected in each quadrangle. Probably its greatest value, however, will lie in the wealth of material from all parts of the region, and in the detailed information, as to the range, habitat, and associated plants that will be available for each species. It is planned also to include in the herbarium characteristic photographs of many of the plants together with notes on their ecology and their economic importance as grazing or browse plants, or for erosion control.

The survey not only provides information about the present vegetation cover, but also discloses that in many localities its character has been profoundly changed since the advent of the white man. The most striking and significant of such changes are those representing a progressive deterioration from higher and more valuable to lower and less valuable types of vegetation as a result of such land abuse as destructive logging, accidental and wilful summer fires, the practice of annual burning in many foothill and mountain localities, and excessive grazing. As a consequence of such treatment, there have been extensive replacements of commercial timber stands by woodland, chaparral, or sagebrush; of big-cone spruce and Coulter pine by chaparral or woodland; of piñon by chaparral; of grasslands by chaparral or sagebrush; of chaparral by sagebrush.

A compilation of the information obtained in the western or foothill portion of El Dorado County affords an example of the character and extent of the change that has taken place along the western slopes of the Sierra Nevada. Of especial interest in this county is an area of about 162,000 acres, most of which lies between the 1,000-foot and 2,500-foot contour levels and adjacent to, but below, the present belt of yellow pine (*Pinus ponderosa*).[1] The type map shows that this area embraces about 30,000 acres of woodland, 45,000 acres of woodland-chaparral, 5,000 acres of chaparral, 43,000 acres of woodland-grass, 22,000

[1] "Ponderosa pine" is the name now officially recognized by the U. S. Forest Service for *Pinus ponderosa,* probably more widely known as "western yellow pine."

acres of grassland, and 17,000 acres of cultivated land including urban areas, and that most of the tree and shrub species occurring as important dominants in this area are mainly characteristic of the Upper Sonoran Life Zone. Study of the soil in conjunction with growth measurements of scattered second-growth individuals and groups of yellow pine show that this area is capable of growing excellent stands of this conifer. That old-growth stands of yellow pine formerly existed in this area and that lumbering operations had no small part in their disappearance is evidenced by such names as Sawmill Creek, Sawmill Ravine, Shingle Springs, as well as by known locations of early day sawmills including the famous Sutter Mill at Coloma, where the discovery of gold led to the mining rush of 1849.

Other interesting evidences of former pine forests were supplied by survivals of various sorts. Two cemeteries have preserved excellent stands of second-growth pine which would obviously have continued beyond these boundaries if not destroyed. In several localities boundary line fences between forest and non-forest cover coinciding with property line fences also indicate the artificial restriction of range. Still other evidence is provided by the general occurrence of California black oak, a species commonly associated with yellow pine and with much the same habitat requirements. The oak usually survives by sprouting when the pine succumbs to ax and fire.

From the facts accumulated in the survey of El Dorado County, the conclusion seemed warranted that, since the white man settled here, the yellow pine belt has retreated up the Sierra slopes an average distance of ten miles on a thirty mile front. This leaves a deforested area of 162,000 acres much of which has been invaded and occupied by tree and shrub species from non-forest areas below.

Obviously it is possible to present upon the published maps only a fraction of the information accumulated in this survey. Therefore, in order to increase their utility and interest, there is planned a further interpretation of the vegetation types by analysis of the supplementary sample plots and other data. This will be published as regional studies which, upon the completion of the survey, will be combined into a comprehensive whole. The first of these, for which the field survey has already been completed, will cover the Southern California region as embraced by the six counties of Ventura, Los Angeles, San Bernardino, Riverside, Orange, and San Diego. This study will attempt to correlate existing vegetation with various climatic and physical factors. The influence of man on the vegetation, with particular reference to the effect of fire, will be taken into account. The results to be expected from such a study might include among others the following:

1. A partial explanation of the present distribution of vegetation types and dominant species.

2. A better understanding of vegetation changes that have occurred in the past, those now in progress, or those to be expected to occur in the future.

3. Further contributions to our knowledge of the value of certain plants and vegetational types as indicators of particular soil and climatic conditions. These should have an important application in many fields, both in pure research and in applied fields such as game and land management.

4. Suggestions for future investigations and also a foundation for further research.

The projected study is in too preliminary a stage for present discussion other than to mention briefly two first steps which, in addition to the field work, are already under way. One of these is the preparation of maps of the Southern California region on a scale of one-quarter inch to one mile, each showing the distribution of one of the forty-two more important trees and shrubs. Both the dominant and scattered occurrence of the species are indicated on these maps, which are on tracing linen and will be superimposed on maps showing geologic formations, the various climatic factors and fire history. Thus, by these and other means, such as a statistical analysis of the sample plots, it is hoped to determine the rôle of the various factors controlling the distribution of these species. The other step is a systematic search of the literature for references to the character of the vegetation found by the early Spanish explorers and other pioneers in California, also to sawmill and logging operations, fires, and other destructive activities of man. Considerable progress has already been made in this compilation and from the information thus obtained it should be possible, in conjunction with evidence procured in the field work, as illustrated by the El Dorado County survey, to reconstruct a partial picture of former vegetation for comparison with that existing today.

Associate Silviculturist,
California Forest and Range Experiment Station,
January 31, 1935.

RICHARD MORRIS HOLMAN

Richard Morris Holman was born in Allegheny, Pennsylvania, January 9, 1886, and died in Berkeley, California, April 23, 1935. His father and mother were both members of old New England families. His father, who was an attorney, died when the boy was quite young and the family moved to Palo Alto, California, where his secondary school education was completed. He entered Stanford University in 1903 and was graduated with the degree of Bachelor of Arts in 1907. It was during his college course that he became definitely committed to the study of botany as his life work. He served as assistant in the department at Stanford University and remained as acting instructor for one year. He was married to Esther Grace Hopkins in 1909,

and went to the Philippine Islands, where he served as instructor in botany in the Agricultural College of the University of the Philippines from 1909 to 1912. He spent two years, 1912–1914, as a student at the Botanisches Institut, University of Leipzig, in the laboratories of Professor Pfeffer, where he carried on studies in his chosen field of plant physiology. He then returned to California, serving as teaching fellow in the Department of Botany, University of California, 1914–15, where he received the degree of Doctor of Philosophy in 1915.

He served as instructor in botany at the University of Michigan 1915–17, going then to the post of professor of botany at Wabash College where he served during 1917–20. During this period he was also an active member of the State Conservation Commission. He returned to the University of California in the fall of 1920 and served as assistant professor 1920–1926, and as associate professor 1926–1935.

He was the author of a number of scientific papers, and very well known as co-author with W. W. Robbins of the widely used Textbook of General Botany, and Elements of Botany, which first appeared in 1924 and 1928, respectively.

He was a prominent member of several scientific and honor societies and was active also in church and charity organizations.

An outstanding characteristic of Dr. Holman was his love of teaching and his interest in the students who attended his classes. With a large number of these he was personally acquainted. He is mourned by his wide circle of friends and by his mother, his wife, and two daughters who survive him.—Lee Bonar.

REVIEWS

Recherches sur l'Ascension de la Sève. By L. Hauman, Professeur a l'Université de Bruxelles. Académie royale de Belgique. Classe des Sciences. Mémoires. Coll. in 8°. Tome XII, Fasc. 7. 1934.

The author of this paper begins, as we well may, with the rhetorical and factual question—"Two centuries after the publication of Hales' 'Vegetable Statics' (1727), forty years after the publication of Strasburger's great work [Die Leitungsbahnen in den Pflanzen, 1891], and more than twenty years since Dixon first set forth his cohesion theory (1909), has the problem of the ascent of sap finally been solved?"

Of the many theories which have been advanced a very few survive, not because they are convincing, but merely because they are less faulty than others. According to some persons living cells carry the water (sap) from roots to leaves, according to others only physical forces are concerned, while still others contend that the maintenance of that physical system in which movement of water takes place is accomplished only

by living cells. There are, then, many *ideas* regarding the ascent of sap and there are few *convictions* as to the means.

The paper before us records the details of many experiments designed to show the movement of aqueous solutions through the vascular and other tissues of land plants. These experiments suffer, as do most others on this subject,[1] from being conducted not on whole, healthy, undisturbed plants, but on amputated, or at least wounded, portions. This is a fundamental defect; for if, as many investigators including Professor Hauman agree, the water in a plant constitutes a continuous mass, then to interrupt this mass by cuts of any kind is to take the foundation from under one's feet. I may therefore express the opinion that if our author had conducted the same ingenious experiments on whole plants he would have reached somewhat different conclusions. As it is, he has followed good example and has reached orthodox conclusions.

Starting with the proposition that the water in the body of a land plant constitutes a continuous mass, and hence a hydraulic or hydrostatic system co-extensive with the body of the plant, from root-tip to stem-tip and leaf-tips, the components of the mass of water and of the cellular network which supports it are pointed out, namely the vessels and tracheids of the vascular system, the cavities of which may permit rapid movement of large volumes of water; the smaller canals of much less than capillary dimensions in the cellulose walls, permitting only a much slower circulation; and the most minute spaces, between the components of the protoplasm, offering still greater resistance. The continuous loss of water (as vapor) from the surfaces of the plant produces in the different parts of the plant body states of sub-imbibition or of imbibition, of water deficit or abundance, varying in degree with the loss and supply. "It is this state of sub-imbibition, strikingly variable, which determines the ascent of sap and in general all the migrations of the liquid mass." The imbibition forces, known to be very great, constitute the suction force which supplies each part with water in proportion to its degree of sub-imbibition.

The author, assuming the existence of continuous threads or columns of water in the vessels, proceeds to account for the supply of water to all parts of the plant by saying that the cells or parts less well furnished with water draw upon those with more. The direction of the stream, therefore, may continue or may reverse accordingly. This condition of sub-imbibition also furnishes the support, at all points, of those capillary threads which move longitudinally only when drawn upon by the greater sub-imbibition of the tissues concerned. "It is this lateral support at all heights which practically eliminates the weights of the water columns" and enables us to understand the persistence

[1] Peirce, G. J., MADROÑO 3: 1–3. 1935.

of the water columns in spite of the strains produced by heavy winds, whereas water columns in glass may be broken with the greatest ease.

This is, I believe, an especially significant and valuable part of Professor Hauman's paper; for the literature of the subject of water movement contains many accounts of experiments claiming to imitate Nature but ignoring the fundamental difference between an almost unwettable and impervious material like glass, and the thoroughly wettable and permcable material of uncutinized cell walls. Call the water in protoplasm and cell wall what one will, imbibed or bound or fixed, it is held and supported by the materials of cell wall and protoplasm as no glass tube, however clean, can support it. This is proved by the relative times and forces required to dry glass, cellulose, and protoplasm to constant weights. Upon this bound water, or reservoir of water, depends the survival of any given cell or tissue or organism over a period of water deficit, called by Professor Hauman sub-imbibition. This was demonstrated on a great scale in the middle western states in the summer of 1934 by the trees which survived the drought.

A no less important contribution to an understanding of the movement of water in plants is Professor Hauman's discussion of what he calls the extra-vascular circulation. Pointing out that the water taken in by the root hairs from the soil travels for some distance from them before it reaches the vascular tissues in the roots, and that water from the vascular tissues in the leaves again travels some distance through the other tissues before it evaporates, he explains these apparently osmotically contrary movements as not osmotic at all but as movements of imbibed or bound water of and in the cell walls. This is a perfectly valid claim, and it is probably true; but it would have been more fruitful to use, in the experiments employing dyes, such dyes as would be able to penetrate and be absorbed by the living cells *if* the water did enter. The adsorption of certain dyes by cellulose and cellulose derivatives, as is well known, is so much greater than by protoplasm, that it would be advisable to use dyes which could be equally adsorbed by proteins and carbohydrates, if the solvent actually penetrated living cells. In other words, although solvent and solute do move in their own individual and characteristic ways, the solute (dye) would indicate its presence by the extent to which it stained its adsorbing medium, whether cell wall or protoplasm, and if deeply or only faintly staining the protoplasm would indicate both its own presence and also the course of the stream of water. If, as Professor Hauman himself says, there is no staining of protoplasm, it does not necessarily follow that there is no movement of water: but if, on the other hand, there were abundant staining of protoplasm by a protein dye, one could hardly resist inferring a corresponding movement of water.

That the movement of water from the absorbing root hairs to the vascular elements is through the walls and not through the cells, and is swift, Professor Hauman concludes from experiment. He shows that, under conditions of sub-imbibition, acid fuchsin pigment, taken in by the wounded surface of radicles cut off from young seedlings, will quickly reach the walls of the root hairs.—G. J. P. Stanford University, January, 1935.

A Manual of Southern California Botany. By PHILIP A. MUNZ. Pp. xxxix + 642, with 310 figures. Published by Claremont Colleges, April 5, 1935. $5.00.

This book is a welcome addition to the published accounts of the flora of California. It fills a need for a treatise of the plants of a section of the state heretofore only incompletely covered. It is a handbook convenient in size, adequately illustrated, well bound, and containing 642 pages. Southern California as defined by the author "includes Los Angeles, San Diego, Orange, Riverside, San Bernardino and Ventura Counties as well as portions of Santa Barbara, Kern and Inyo Counties." Imperial County was probably inadvertently omitted from the list.

In addition to the formal taxonomic treatment of genera and species, there is much interesting and suggestive introductory material on the physical features of Southern California and the endemic aspects of the flora. It is regrettable that the size and scope of the book did not permit of further elaboration of the conclusions and theoretical aspects to be derived from this remarkable fund of new material pertaining to these subjects. Following the taxonomic treatment is a list of nomenclatorial changes and Latin diagnoses of new species and varieties. A list of persons for whom Southern California plants have been named with a brief biographical statement of each is included, as well as a section, contributed by Frank W. Peirson of Pasadena, dealing with the meanings of the scientific names of the species listed in the manual.

The book is the result of several years of capable research. The genera and species are well described. An ultra-conservative point of view is taken toward most controversial taxonomic problems. For example, in Polemoniaceae the genera *Gilia, Langloisia, Loeselia, Linanthus, Navarretia, Leptodactylon,* and *Hugelia* are lumped together in *Gilia,* necessitating two and one-half pages of key to fifty-nine species.

Certain mechanical defects present themselves. Owing to irregularity in the size of the matrix used, the printed matter sometimes comes perilously close to the lower edge of the paper (page 123) while on other pages the margin is noticeably wide (page 6). The illustrations for the most part are well done. It is unfortunate that the author did not place an explanatory caption with the drawings. More careful proof reading would have eliminated many typographical errors.—H. L. M.

University of California, May, 1935.

THE INTRODUCTION OF EUCALYPTUS INTO CALIFORNIA

H. M. Butterfield

The exact date of the introduction of the eucalyptus into California has been somewhat in doubt, so the writer in his study of the history of ornamentals has watched carefully for facts which would throw more light on this subject. Certain bits of new evidence have been discovered and are presented here with the hope that the reader will be better informed as to when the eucalyptus was first introduced and what species were involved.

There is little doubt that nurserymen in early days knew a good deal about the introduction of eucalyptus, but after the death of these nurserymen any statement seen in print without supporting evidence cannot be given much weight. For example, in A. J. McClatchie's publication, "Eucalypts Cultivated in the United States,"[1] we find the following statement regarding the introduction of eucalyptus into California, "It is reported that they were introduced into California in 1856 by Mr. Walker, of San Francisco, and in that year 14 species were planted. In 1860 Mr. Stephen Nolan, a pioneer nurseryman of Oakland, being greatly impressed with the rapid growth of these first trees, and also with their evident adaptability to the climate, commissioned a sea captain sailing for Australian ports to secure any Eucalyptus seed he could, at the same time furnishing money with which to make the purchase. A large supply of seed of several species, including *Eucalyptus viminalis* was received from this source, and sown in 1861. Mr. Nolan continued to import seed in quantity for several years, distributing the seedlings widely through the state." These statements intrigued the writer. Who was Mr. Walker and where did he operate? Who was Mr. Nolan? Did these men leave any supporting evidence for such statements as those just quoted?

It was almost too much to hope that a copy of Mr. William C. Walker's catalog would still be in existence today. When the writer sought information on certain trees of *Cedrus deodara* planted in San Francisco before 1860 he consulted Miss Alice Eastwood, of the Academy of Sciences, Golden Gate Park, San Francisco. She modestly mentioned a catalog which she had secured a number of years before from the late Charles Abrahams, nurseryman of San Francisco. Fortunately the writer was able to consult this old catalog, and on the inside of the front cover was found written, "Catalogue of the Golden Gate Nursery —1858 and 1859." It was a simple detail to supply the name of

[1] Bur. of Forestry Bull. 35. U. S. D. A. 1902. 106 p. See p. 18.

Madroño, Vol. 3, pp. 149–180, October 1, 1935.

the owner of the Golden Gate Nursery[2]—none other than Mr. William C. Walker, who was mentioned in the quotation above. This is not just an ordinary catalog but evidently the master copy for Mr. Walker's catalog for 1858 and 1859, and all in his own interesting handwriting. At the bottom of page 24 we see listed:

"Eucalyptus Resinifera	(Aus.)	—splendid weeping forest tree 60 ft.	$10.00
" argentea	"	—argentea foliage 20 ft.	10.00
" angustifolia	"	—dwarf 5 feet	5.00"

Previously the writer had seen eucalyptus mentioned in Mr. Walker's advertisements in the "California Farmer" for 1857 but there was no mention of the species grown. Now we have evidence of what he actually listed in his catalog only a year later. Perhaps Mr. Walker had other species but not enough to justify listing.

Anyone who has introduced seeds from other countries knows that there is a big step between having the seed and selling living plants from these seeds. A nurseryman has to continue buying seeds in such a case as that just mentioned. Mr. Walker was no exception. In the master copy of his catalog for 1858 and 1859 we find a list of seeds received from M. Guilfoyle, Sydney, September 15, 1859. The *Eucalyptus* species mentioned were:

"Eucalyptus robusta
" sp. Iron Bark 70 ft.
" Blue Gum
" sp. Longifolia
" nigra. Van Dieman Land
" globosa " " " (globulus ?)"

Just what is meant by "Iron Bark" is doubtful, yet we know that *Eucalyptus sideroxylon* and *E. leucoxylon* were species of iron barks brought in at an early date and it is likely that Mr. Walker referred to one of these. He thought that *E. globosa* might have been the blue gum (*E. globulus*) and that is a reasonable assumption. *E. robusta* (Swamp Mahogany) is well known. *E. longifolia* (Woollybutt) was listed by others in early days. *E. nigra* is only rarely mentioned in the literature. *E. angustifolia,* which Mr. Walker listed at $5.00 a plant, is now referred to as *E. amygdalina* var. *angustifolia,* and it is still one of our most beautiful ornamental species of *Eucalyptus*. *E. argentea* listed by Mr. Walker has not yet been associated with any recognized species. *E. resinifera* (Red Mahogany) is too well known today to require special mention.

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[2] For a description of Mr. Walker's nursery see Transactions of the California State Agricultural Society, 1858, p. 266.

PLATE IV. THE CAPTAIN ARAM BLUE GUM (EUCALYPTUS GLOBULUS).

Reference was made to Mr. Steven Nolan, who established his nursery in Oakland in 1860 and continued until about 1877. Again the writer was lucky in finding an old catalog of Mr. Nolan's for the year 1871 and can now report exactly what he was growing in those early years. This catalog is in the possession of one of Mr. Nolan's daughters, Mrs. W. F. Snyder (Rose Nolan) of Berkeley. *Eucalyptus* species mentioned in the catalog for 1871 are listed as follows: *E. acemenoides* (White Mahogany Gum); *E. amygdalina* (Black Peppermint Gum); *E. angustifolia* (*E. amygdalina* var. *angustifolia*); *E. calophylla* (Marri or Western Australian Red Gum); *E. cordifolia* (?); *E. cornuta* (Yate-Tree); *E. corynocalyx* (*cladocalyx*) (Sugar Gum); *E. eugenioides* (White Stringybark); *E. fissilis* (*obliqua*); *E. gigantea* (Red Mountain Ash); *E. globulus* (Blue Gum); *E. gunni* (Cider Gum); *E. hemiphloia* (Grey Box); *E. lanceolata* (?); *E. leucoxylon* (White Ironbark); *E. longifolia* (Woollybutt); *E. maculata* (Spotted Gum); *E. marginata* (Jarrah); *E. montana* (*gunni* var. *montana*); *E. obliqua* (Messmate Gum); *E. occidentalis* (Flat-topped Yate); *E. odorata* (Messmate Stringybark); *E. paniculata* (Grey Ironbark); *E. pendula* (?); *E. pilularis* (Blackbutt); *E. piperita* (Peppermint Stringybark); *E. polyanthemos* (Red Box); *E. pulverulenta; E. radiata* (*E. amygdalina* var. *radiata*) (River White Gum); *E. robusta* (Swamp Mahogany); *E. stricta* (Scrubby Gum); *E. stuartiana* (Apple-scented Gum); *E. tereticornis* (Grey or Slaty Gum); *E. viminalis* (Manna Gum).

Most of the species just mentioned were listed at 25 cents to 50 cents each. *E. hemiphloia* and *E. stricta* brought 75 cents each. The chances are that not many people bought trees from Mr. Walker at $5.00 to $10.00 each, but by 1871 *Eucalyptus globulus* (Blue Gum) had dropped to 10 cents and 25 cents each. That helps explain why so many eucalyptus trees were planted in the seventies but apparently not many in the first years following introduction.

There may be some people who would like to know whether eucalyptus was actually planted in California gardens in the early years and, if so, where. We have a few scattered cases which will show that the eucalyptus was planted throughout California in the more important settlements of that day. A few trees were set out on Telegraph Avenue, Oakland, near the military academy in 1862. George Potter, of Oakland, had a nine-year-old tree in 1873 which was a foot in diameter. A tree planted by Richmond Davis about 1863 at the corner of G and 15th streets, Sacramento, had reached a height of 60 feet in 1875. These plantings are mentioned in the "California Horticulturist," published in San Francisco, 1870 to 1880. Mr. Rose of San Gabriel planted a tree about 1864. In 1872 this tree was 75 feet tall.[3] In 1865 John Hall planted three trees of *Eucalyptus*

[3] This fact is mentioned in a book "California" by Charles Nordhoff, Harper Bros. N. Y. 1875.

globulus at his place, located about a mile east of Alvarado, at what is now Hall's Station. Mrs. J. E. Branin of San Lorenzo, now in her ninetieth year, recalls seeing the three young trees brought back from San Francisco and planted. Captain Joseph Aram who established a nursery[4] on Milpitas Road, San Jose, in 1856, evidently planted a tree at an early date. The large specimen of *Eucalyptus globulus* (pl. IV) now growing on the site shows signs of age. Bishop William Taylor of the Methodist Episcopal Church sent seeds of eucalyptus to his wife in Alameda shortly after he went to Australia in 1863. A tree from this seed is still standing at Central and Park avenues, Alameda.

Bishop Taylor has been given credit by some people as being the first to introduce eucalyptus into California. This idea can probably be traced to the following statement made by him[5]: "There were no such trees on the Coast . . . in 1849. I sent the seed from Australia to my wife in California." Evidently some have been led to associate the year 1849 with this shipment of seed by Bishop Taylor when as a matter of fact he did pioneer work in California from 1849 to 1856 and first went to Australia in 1863. By that time the eucalyptus was widely distributed in California, as the above cases taken from publications of that early day indicate. It is true, as Bishop Taylor said, that the eucalyptus was not growing here before 1850. Charles Nordhoff and others have made the same statement. With all of the available facts at hand we can still say that William C. Walker, of the Golden Gate Nursery, Fourth and Folsom streets, San Francisco, is the first definitely on record as having imported seeds of the eucalyptus into California. Stephen Nolan, who established his nursery in 1860, on Telegraph Avenue, Oakland, about where Thirty-fourth Street is now cut through, was the second to make noteworthy importations. No doubt many other people have brought in seed from Australia but these two had the greatest influence and were the first, so far as we know, to make importations.

We should not conclude this early history without mentioning a few of the notable eucalyptus trees still growing in California. The Captain Aram blue gum, on the bank of Coyote Creek, San Jose, near Milpitas Road, is now 95 inches in diameter, breast high, and about 105 feet in height. Trees with a similar diameter have recently been reported from Solano and Orange counties. The J. C. McCubben manna gum in Tulare County, between Reedley and Dinuba, was planted in 1889 and now has a diameter of about 85 inches, breast high. The three blue gums

[4] For description of this orchard and nursery in 1858, see "Transactions of the California State Agricultural Society," 1858, p. 255.

[5] See preface of "Story of My Life" by Bishop William Taylor, also leaflet issued by his son William Taylor at time of Centenary Memorial Service, Mountain View Cemetery, May 22, 1921.

planted by John Hall east of Alvarado in 1865 are still standing. The grove of blue gums on the University of California campus, Berkeley, was planted shortly after 1870 and some of these trees are now over 170 feet in height. The date is based upon statements made to the writer by a daughter of Rev. Samuel H. Willey who lived in Berkeley up to 1870, and by Joseph Rowell, archivist of the University, who has lived continuously in Berkeley since September, 1873. Pictures in possession of the writer further confirm the general age of the campus trees. A large manna gum on the campus at Berkeley is 64 inches in diameter, breast high. Several other trees of notable size could be included in this list, but all these belong to a later day. People who have unusual specimens of eucalyptus to report or who have additional facts concerning the early history of the eucalyptus in California are invited to get in touch with the writer or the Extension Forester, College of Agriculture, University of California, Berkeley.

The eucalyptus is now one of the outstanding trees on almost any California landscape where trees have been planted. Many people fail to realize that this tree is not a native. At this late date we can pay our respects to the early pioneers, such as William C. Walker and Stephen Nolan, and hope that some of our present generation also will be inspired to become pioneers in the introduction of worthy exotic trees to supplement our rich native flora.

College of Agriculture, University of California,
August, 1935.

ON THE GENUS PITYOPUS

Herbert F. Copeland

The genus *Pityopus* has been something of a mystery. The name seems to mean "pine foot." Published by Small twenty years ago, the original description could be overlooked by no student of the saprophytic plants which make up the monotropoid alliance: but there have heretofore been no additions to our knowledge of the plant, nor even any reports of new collections. A single species, *P. oregona,* was described. It was suggested that a plant collected by Eastwood and described by her as *Monotropa californica* might represent the same species. But meanwhile Domin reduced Eastwood's plant (of which he could have seen no material) to a variety of *Monotropa Hypopitys.*

My studies, pursued with much deeply appreciated assistance (more detailed acknowledgements are made below), enable me to list six collections. The suggestion that *Monotropa californica* is identical with *Pityopus oregona* is confirmed. The long aban-

doned "Rule of Kew" would have spared me the formal necessity of giving this species a third name. Publication of the following involves responsibility; no "credit" is available.

Pityopus californica (Eastw.) Copel. f. comb. nov. *Monotropa californica* Eastwood, Bull. Torr. Bot. Club 29: 75–76, pl. 7, figs. 1–9. 1902. *Pityopus oregona* Small, North American Flora 29: 16. 1914. *Monotropa Hypopitys* var. *californica* Domin, Sitzber. böhm. Ges. Wiss. II Classe, I Stück p. 24. 1915.

Known collections: OREGON. North of Mount Hood, *Thomas Howell,* July 3, 1891 (Herb. N. Y. Bot. Gard.); Curry County, Rogue River between Lowery's and Agness, *L. F. Henderson,* July 6, 1929 (Herb. Univ. Oregon); Lane County, Westlake, *Mrs. Lucina Richardson,* May 18, 1928 (Herb. Univ. Oregon). CALIFORNIA. Hupa Indian Reserve, 1000 ft., *Harley P. Chandler,* June, 1901 (Herb. Univ. Calif.); Marin County, Little Carson Creek, *Alice Eastwood,* May–June, 1901 (Herb. Calif. Acad. Sci.); Fresno County, Sequoia Lake, 5500 ft., *George H. Quick,* July, 1934 (Herb. Univ. Calif.).

For the opportunity to examine Quick's specimen and for other favors, I am indebted to Dr. H. L. Mason. Examination of this specimen was the occasion for the present study; fragments from it were the material for the anatomical work reported below; all the drawings except figure 3 of Plate V were made from it. It consists of the upper part of a single shoot preserved in alcohol.

My inquiries after Howell's specimen at the New York Botanical Garden were courteously answered by Dr. Small and Dr. Gleason; but these gentlemen and I were disappointed by the discovery that the specimen had disappeared.

Miss Eastwood made two collections of the plant at the same locality. A single very immature shoot, collected May 30, 1901, survives as a dried specimen. The more important collection made a week later, the basis of the description and illustration of *Monotropa californica,* was preserved in alcohol and was lost in the disaster of April, 1906. The collector's subsequent careful searches in the field have revealed no more of the plant. The situation of *Pityopus californica* is unusual; the type specimens of the genus and of the only species were distinct, and both are lost. I was permitted to dissect a scrap which had been taken from Eastwood's surviving specimen and given to the University of California. It was so very scant and immature that I tried imbedding it in paraffin and sectioning with a microtome. The result is a lot of sadly shattered sections (imbedding in collodion might have yielded better results); nevertheless, the crucial question as to whether the placentation is parietal or not is answered in the affirmative.

Chandler's specimen, consisting of the upper parts of two shoots, collected by coincidence the same month as Eastwood's

lost material, had lain all these years in the Herbarium of the University of California with a doubtful identification as *Monotropa fimbriata.*

The inadequacy of the material already mentioned is obvious. Hoping against hope for a chance to see better material, I wrote to the University of Oregon. Mr. L. F. Henderson, the veteran botanist of that institution, had the kindness to lend two very abundant and excellent specimens. These have fully satisfied me as to the identity of the other collections.

Gross Morphology

Pityopus shows many of the characters of *Hypopitys;* specimens of the rare genus are likely to be misidentified as representing the commoner one. The essential difference is in the placentation, which is in *Pityopus* parietal, in *Hypopitys* axile. There are other, more readily observed, differences. Shoots of *Pityopus* are strictly erect, and when in full flower are said to be white (except the yellow stigma and pink anthers). Presumably they darken with age; dried and preserved specimens are intensely black. Excepting the interior of the flower, the plants are essentially glabrous. They are often distinguishable from *Hypopitys* by greater size; stems commonly exceed 1 cm. in diameter; the perianth is usually over 1 cm. long. Henderson's collection shows intergrades between the ordinary stout and massive type and such diminutive individuals as Eastwood's surviving specimen.

Whole plants are approximately 7 to 20 cm. tall. Roots have been seen only on Mrs. Richardson's collection; they are like those of related plants, forming small globular clusters at the bases of the shoots.

The shoot consists of a scaly stalk bearing a bracteate inflorescence. The largest foliar organs are the highest "leaves" and lowest "bracts" at the transition from "stem" to "rachis"; these may be 2 cm. long; the lower "leaves" and higher "bracts" are smaller. "Leaves" are generally ovate, entire, rounded, attached by the broad base; "bracts," especially the upper ones, are narrowed below (*i.e.,* cuneate as to base), erose as to margin, more or less acute.

Domin (3) has devoted several pages to elucidating the great variety of inflorescence observed in *Hypopitys.* He treats all the races of this group as varieties of *Monotropa Hypopitys.* The inflorescence of *Pityopus* is similarly variable; but without an extensive set of preserved collections (as distinguished from dried specimens) it is not possible to describe it in detail. Sometimes (*cf.* Eastwood's fig. 1) there is a terminal flower which opens before the others. On the other hand, Quick's specimen appeared to show a typical raceme, the flowers opening in acropetal succession and the summit of the rachis occupied by an ordinary

terminal bud, a body of rudimentary bracts and flowers. In this raceme, each flower is terminal on an axillary pedicel which is stout and naked; the lowest pedicels are about 1 cm. long. In Henderson's collection and in Mrs. Richardson's, another variation appears. The axillary structures are not the pedicels of single flowers, but are cymelets each consisting of a short secondary axis bearing bracts, axillary flowers, and a terminal flower which opens first.

The flowers may be pentamerous or tetramerous. In Eastwood's figure the terminal flower is pentamerous. This is the condition of the flowers of Mrs. Richardson's collection; in Henderson's the flowers are tetramerous. In both collections the terminal and axillary flowers seem to be alike, pentamerous or tetramerous as the case may be. The flower of Quick's collection (pl. V, fig. 1) are tetramerous.

Small described the sepals as four or five in number. Ideally, no doubt, they are as many as the petals; actually they are often fewer. On Mrs. Richardson's specimen, most flowers of which have five petals, Henderson noted "Calyx-bracts generally 2, often 4." Two flowers of Quick's specimen showed respectively a whorl of three (the abaxial sepal, sheltered by the bract, being suppressed) and a whorl of three with a fourth inserted at a higher level, among the petals. These sepals in fully developed flowers are 1 cm. long or a little more (about 2 cm. long in an apparently monstrous flower of Chandler's collection); they are glabrous, elliptic to obovate, ordinarily acute, erose.

The petals are slightly longer than the sepals. They are slightly but definitely saccate at the base, commonly obovate, acute, erose, glabrous without and densely pubescent within.

Of stamens I have consistently found twice as many as the petals. They are variable in length, usually slightly (sometimes considerably) shorter than the pistil. The slender filaments are densely pubescent above. I have not seen anthers before dehiscence. All the anthers seen had doubtless been more or less globular (cf. Eastwood's figs. 6–9). They can be described as usually opening by a single valve on the outer or dorsal side (pl. V, fig. 2; cf. Eastwood's fig. 9). In two individuals of Henderson's collection, the valve has consistently failed to become free at the summit, and the anthers may be said to open through widely gaping pores (pl. V, fig. 3). It is hard to harmonize these observations with the original description, "each sac opening by a short slit on the side." Possibly that was based on young anthers of which the pores would later have gaped widely.

The nectary consists of a belt around the base of the ovary, and, borne upon it, a whorl of mamilliform projections. These projections are arranged in pairs opposite the petals and embracing the bases of alternate stamens. They are less prominent than the similarly placed projections of *Hypopitys,* as described

by Oliver, and very much less prominent than the rod-shaped projections of *Monotropa uniflora.*

The pistil (pl. V, fig. 4) is about as long as the perianth. The upper part of the ovary and the style are pubescent; there is a conspicuous collar of hairs just below the stigma, as in *Monotropa, Hypopitys,* and *Newberrya.* The superior ovary is globular, up to 7 mm. in diameter or even larger in some flowers of Chandler's collection. The style is about as long as the ovary; the stigma is capitate. This character is not well brought out in Eastwood's figure 5, but is evident in the surviving specimen of her collection.

There is, on the upper surface of the stigma, a deep depression which is actually an opening into the fluted style-channel. The latter leads to the interior of the ovary, which is almost filled by several placentae. These placentae are essentially of the same structure as in *Newberrya,* but are massive rather than trilamellate, appearing ovate or lanceolate rather than hastate in cross section. They are connected to the walls of the ovary by bands of tissue which appear in cross section as narrow isthmuses. The normal number of placentae is apparently twice the number of petals; actually, in three ovaries of Quick's specimen there were respectively seven, nine, and eight (of which two were partially coalescent). Henderson noted six or seven in Mrs. Richardson's collection. In Chandler's collection there are more than five, but the exact number could not be determined in the dried material. In the shattered sections of the ovary from Eastwood's collection, several internal masses were recognized as placentae by the presence of vascular tissue (this would be absent from the septa of a plurilocular ovary); but the number could not be determined.

Anatomy

From Quick's specimen were removed a length of stem, two whole flowers, and fragments of two others. These objects were transferred through the series of mixtures recommended by Zirkle (15) to butyl alcohol; imbedded; and sectioned. Both cross and longitudinal sections were made from the stem. From the two whole flowers, serial cross sections, respectively at 15 and 20 microns, were cut. The fragments of flowers furnished longitudinal sections of the pistil. The sections were mounted and stained in various fashions, mostly with safranin and light green. Some were cleared in xylol and mounted in balsam without staining; the black pigment present in the material made it possible to see many details. Preservation in alcohol was found to have fixed the material satisfactorily for most purposes; only the ovules were decidedly unsatisfactory. Incidentally, the series of mixtures of ethyl and butyl alcohols recommended by Zirkle for dehydrating fixed objects was found equally satisfactory for hydrating and dehydrating mounted sections in the process of

staining. The different series of mixtures which Zirkle (16) has more recently suggested for use in the latter process is unnecessary for ordinary anatomical purposes.

In the course of describing this material, I shall have occasion to compare *Pityopus* with related plants. For comparison I have several sets of serial sections of *Pterospora* and *Sarcodes;* a few of *Newberrya,* already described (2); and an abundance of material of *Pleuricospora.* I look forward to preparing an account of the morphology of this last genus, but it is harder to do justice to unlimited material than to such scraps as I have had of *Newberrya* and *Pityopus.* Much work on *Hypopitys* has been published in Europe; I have not had access to all of it, but the older papers are summarized by Drude (4). The account of *Sarcodes* by Oliver (10) is well known. The ovules of the group are described by Koch (9), Samuelson (11), and Schnarf (12). I may also cite my own recent publications (1, 2).

The roots of monotropoid plants are known to show peculiarities. In *Hypopitys* the branch roots originate in normal fashion, that is, internally. In *Sarcodes* and *Pterospora,* Oliver made the interesting discovery that branch roots arise exogenously; and I have found that the same thing is true in *Pleuricospora.* Some authors[1] have concluded that the monotropoid plants possess no true roots, but instead an organ *sui generis* to be called the procaulon. For the discussion of this interesting problem it is not yet possible to draw any data from *Pityopus.*

The stem shows in cross section (pl. V, fig. 5) an epidermis, a cortex, a vascular cylinder, and a large pith. Pith and cortex alike consist of large cells elongated parallel to the axis of the stem. The walls are thin and show abundant thinner places or large and very shallow pits. The cells of the epidermis are somewhat smaller than those of the cortex. There is a thin cuticle; it shows obscurely a tendency toward the ridged condition which is more conspicuous on the floral organs.

The vascular cylinder is of a small but varying number of layers of cells. The cells are mostly slender, elongate, thin-walled, and nucleate. Cells recognizable by lignified walls are remarkably scarce. They occur in scattered patches on the inner side of the vascular cylinder (indicated in figure 5 [pl. V] by little specks of solid black). The arrangement of these patches is definite to the extent that they are absent from the leaf traces; possibly with more abundant material other regularity could be made out. The lignified elements are spiral or scalariform. The cylinder as a whole is star-shaped. The angles are directed toward leaf-attachments; leaf traces, each consisting of a single strand and leaving a single gap, are recog-

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[1] Domin (3, pp. 47–49) accepts this view and cites several works of Velenovsky, especially his Vergleichende Morphologie der Pflanzen Bd. II (1907) p. 367.

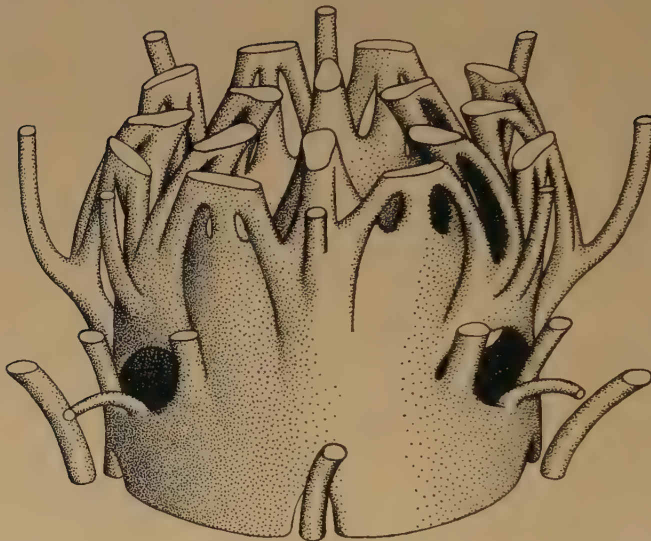

Fig. 1. Reconstruction of the vascular system in the receptacle, approximately × 25.

nizable. This structure is essentially identical with that of *Newberrya* and *Pleuricospora*. In *Pleuricospora* there are, in the stem proper, no axillary bud- or branch-traces; in the axis of the inflorescence, each flower trace consists, as one would expect, of two conspicuous bundles, one on each side of the bundle which runs to the subtending bract. It is assumed that the structure is the same in *Pityopus*.

In the pedicel the vascular tissue forms a cylinder. Near the receptacle the sepal traces become separated by rays of ground tissue from the rest of the cylinder. The small gaps left by the departure of the sepal traces are closed at a slightly higher level. Deviations from the normal arrangement of the sepals are reflected in the vascular anatomy. Of the two flowers from which my sections were made, one, lacking a sepal on the abaxial side, shows no vestige of a sepal trace on that side; the other (pl. VI, figs. 1–4), in which one sepal is inserted at a higher level than the others, has the bundle supplying it at about the same level as the petal traces.

The vascular supply to each petal consists of three bundles; the median bundle, which bends downward to pass under the nectar sac of the petal, is smaller than the laterals, which pursue an upward course from the beginning. The departure of the three bundles to each petal leaves a single large gap which closes quickly. No very significant irregularities were observed in this

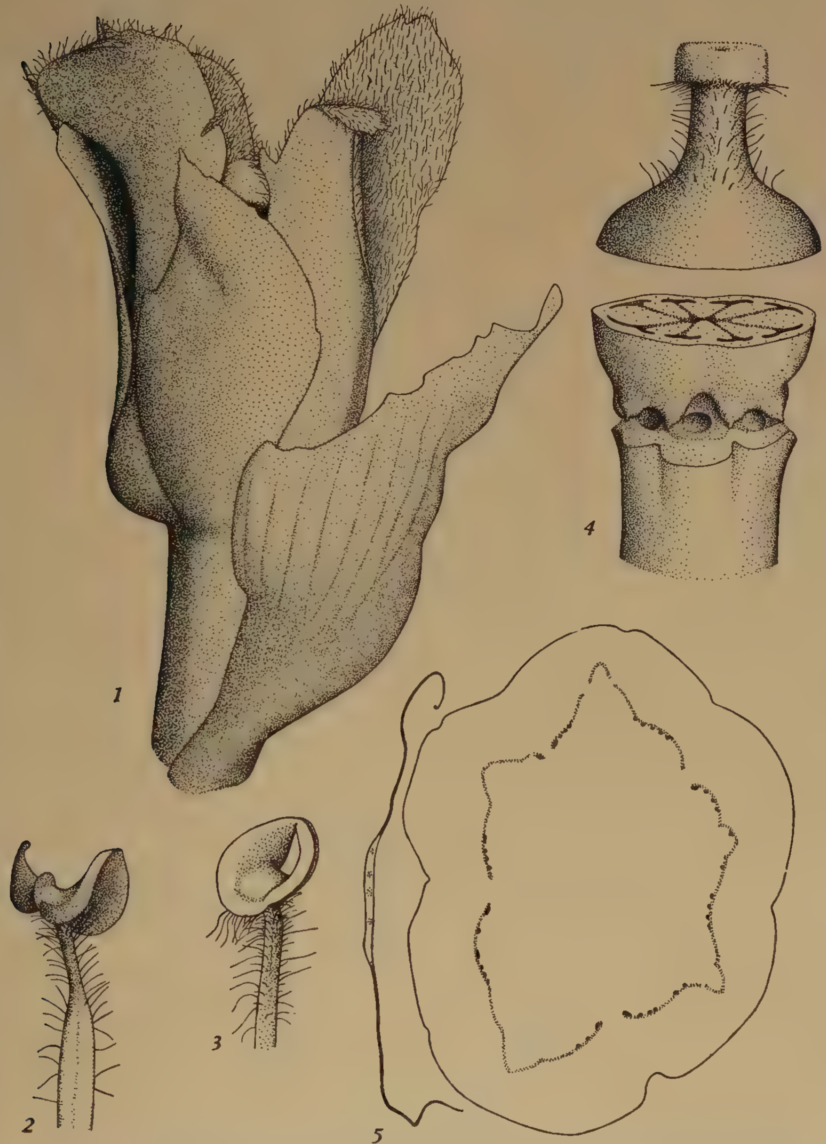

Plate V. Fig. 1. Flower × 5. Fig. 2. Anther × 10. Fig. 3. Anther from Henderson's collection × 10. Fig. 4. Sectioned pistil × 5. Fig. 5. Cross section of the stem × 5.

whorl: one of the laterals may arise from the side of the median bundle, or vice versa.

The structure of the vascular system above the insertion of the petals varies to some extent from sector to sector (pl. VI, figs. 3, 4; pl. VII, figs. 1–3). It is possible to figure out what the arrangement would be if all the bundles were fully developed (text fig. 1); the result is not easily interpreted in terms of the commonly accepted theory of receptacular vascular anatomy as it has been expounded by Eames and others (5, 6 pp. 279–284, 7, 8, 13, 14).

From the vascular cylinder depart eight large bundles, leaving small gaps. One of these bundles is directed toward the base of each stamen. The ones which lie in the radii of the petals arise at a slightly lower level than those opposite the sepals. This arrangement is related to the existence of a pair of the mamilliform projections of the nectary opposite each petal, and to the consequent somewhat lower insertion of the stamens between them; it is not taken as an indication that the stamens form more than one whorl. The bundles just mentioned are not simply stamen traces. They fork periclinally, and only the outer and much smaller branches run in a radial direction into the bases of the filaments. The larger, inner branches proceed upward into the base of the ovary, toward the inside from the glandular tissue of the nectary. For purposes of definite reference, I may call these the supernumerary bundles. They may presently fade out; but usually, either without branching or after forking into two or three parts, they become part of the vascular system of the pistil.

Above the departure of the bundles just described, the vascular cylinder breaks up into an indefinite number of separate bundles. The bundles lying more or less in the radii of the stamens pass into the placentae. The supply to each placenta seems often to consist of two or more bundles, and may be regarded as representing the paired ventral bundles of adjacent carpels. The bundles which do not pass into the placentae become carpel dorsal bundles and proceed up the wall of the ovary, one of them in each space between the attachments of two placentae.

If, in the base of an ovary, a "supernumerary" bundle has divided into three branches, then the middle branch, lying in the radius of a stamen and a placenta, bends inward and increases the vascular tissue of the placenta; while the two lateral branches diverge and finally become fused with the adjacent carpel-dorsals. If a "supernumerary" bundle fades out or fails to divide into three parts, then one or more of the connections just described remains unmade.

The difficulty of interpretation mentioned above lies in the "supernumerary" bundles. These are constantly present, fused

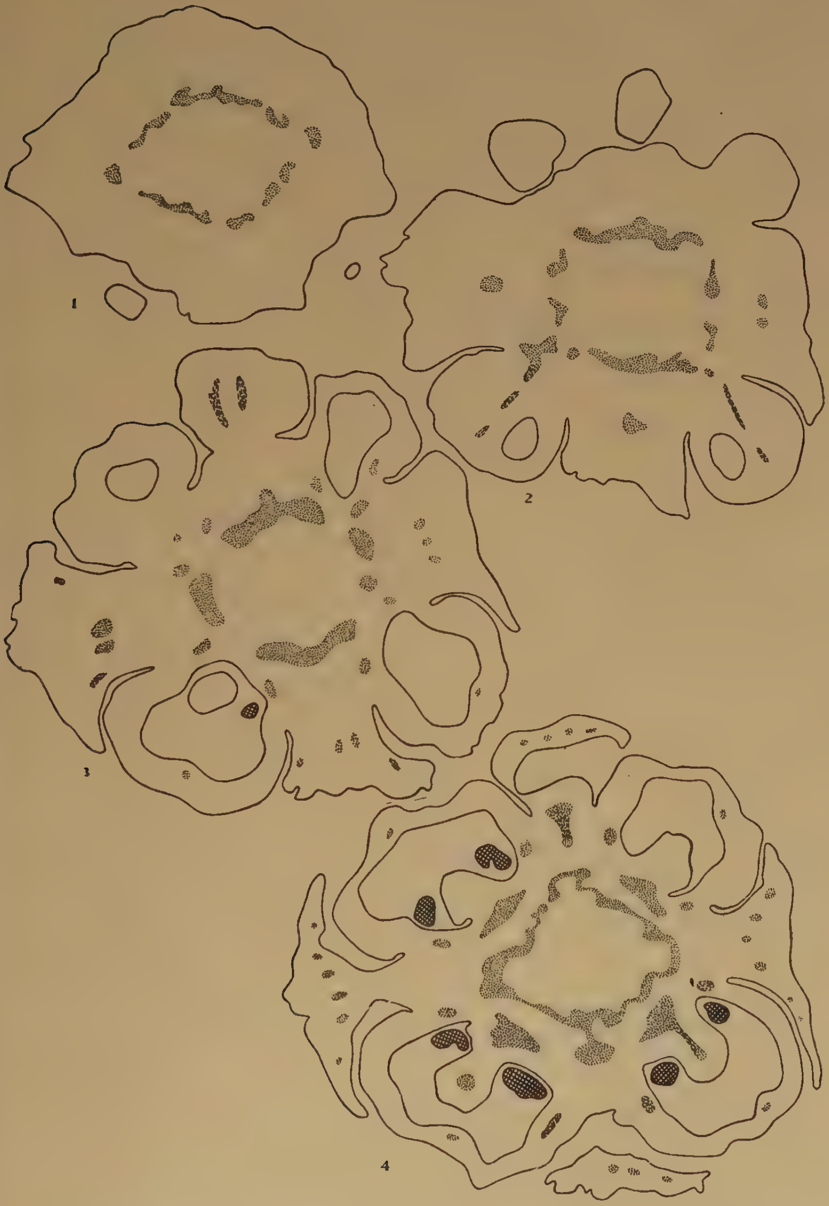

PLATE VI. Figs. 1–4. Cross sections of pedicel, receptacle, and flower × 10. The interval between figs. 1 and 2 is 0.5 mm; between 2 and 3, 0.3 mm; between 3 and 4, 0.35 mm. Vascular tissue stippled; nectary cross-hatched.

to the ventral side of the stamen traces; they enter the pistil along the radii of the placentae, that is, in positions alternating with the theoretical positions of the carpels; and typically, as I take it, they fork trichotomously. One possible interpretation is that these are the valid pairs of fused carpel-ventral bundles from adjacent carpels; this may be the true interpretation in spite of the fact that branches run back from them to the carpel-dorsals, and that they do not constitute the main vascular supply to the placentae. Another interpretation would make the "supernumeraries" represent an outer whorl of carpels, alternate with and completely adnate to the proper carpels, and so completely suppressed as to be recognizable in no feature except these bundles. It is a peculiar fact that in *Newberrya* and *Pityopus* (not *Pleuricospora*) parietal placentation is associated with a double number of carpels. It is conceivable rather than probable that in *Pityopus* the number is actually quadrupled. A third interpretation takes into account the conception, that when carpels are organized as a compound pistil, the new organ is capable of modifications not referable to the carpels which are its elementary components; and recognizes the "supernumerary" bundles as structures *sui generis*. My observations suggest no choice among these possibilities. Possibly studies of *Hypopitys* and *Monotropa* may be helpful; nothing pertinent was noticed in *Newberrya*.

Lignified conducting cells are few in the flower as in the stem; the vascular tissue consists mostly of thin-walled elongate living cells. No peculiarities of the ground tissue were noted. The epidermis of sepals, petals, filaments, and style, and of the upper part of the style channel, bears a cuticle which is externally ridged; the ridges are minute (several to the cell) and sharp, and run parallel to the axis of the flower. The epidermis of the nectary and pistil is notably dark-staining. The small cells which make the nectary also stain darkly, but in a different fashion, showing less affinity for safranin than the epidermis and more for light green.

The hairs, which are abundant on the inner surface of the petals, on the filaments, and on the upper part of the pistil, and which are especially long and stout just below the stigmatic surface, are altogether similar to those of *Newberrya;* they are extensions of epidermal cells, lack cross walls, stain darkly, and are covered with a cuticle which is minutely longitudinally ridged. Within the style channel the cuticulate epidermis gives way to an epidermis of appressed, dark-staining cells without cuticle; this covers the placentae and inner surface of the ovary wall.

The anther walls consist of a single layer of cells, thick-walled, and wrinkled in dehiscence, but without rib-like thickenings. This layer is evidently an exothecium. Normal fully de-

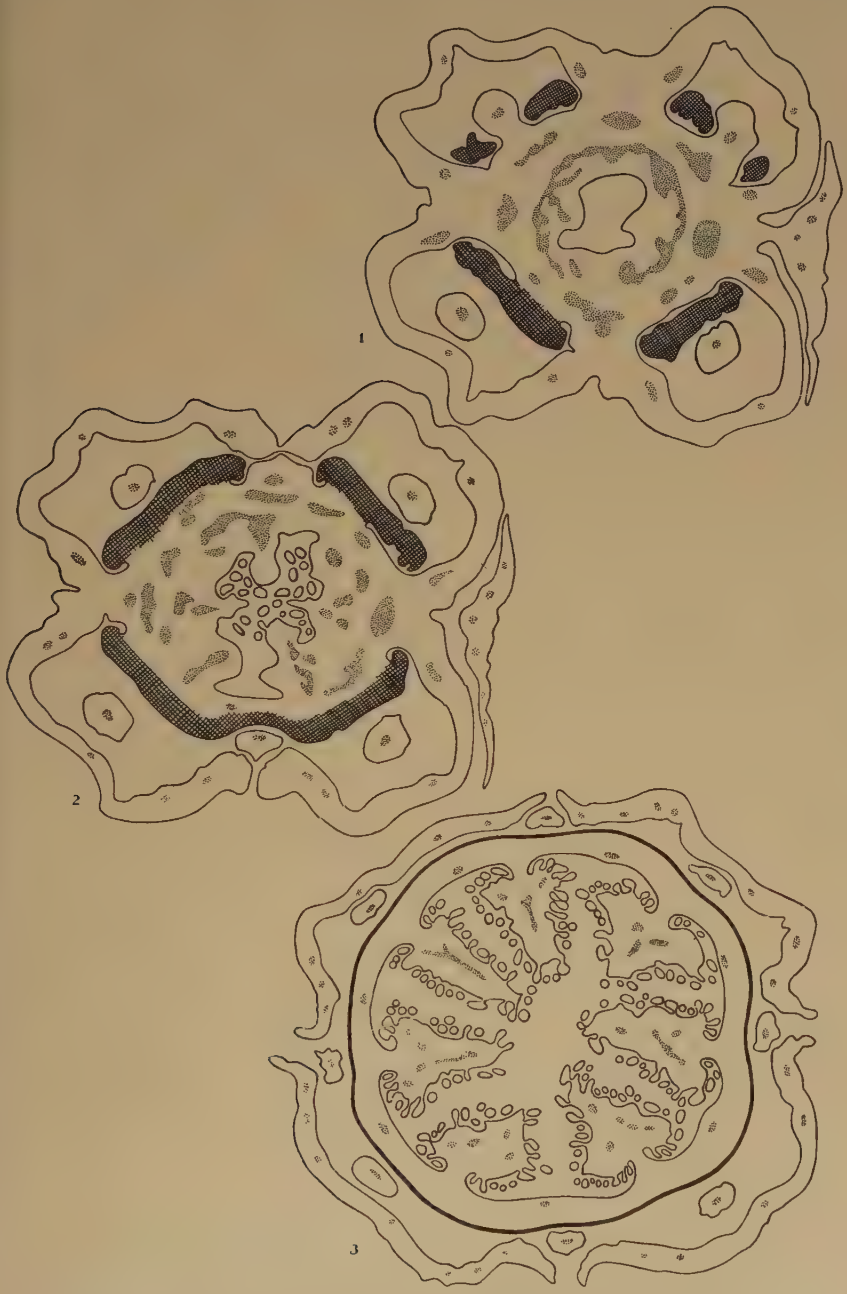

PLATE VII. Figs. 1–3. Cross sections of pedicel, receptacle, and flower × 10. The interval between pl. VI, fig. 4, and pl. VII, fig. 1 is 0.2 mm; between 1 and 2, 0.2 mm; between 2 and 3, 2.2 mm. Vascular tissue stippled; nectary cross-hatched. Sepals are omitted in figs. 1–3.

veloped pollen grains were not seen. The grains as seen on the stigma are solitary (not in tetrads), and smooth walled; they show germination through two opposite pores.

The ground tissue of the style consists of elongate cells compactly arranged in more or less definite rows. As these rows extend into the stigma, the cells become broader and shorter and show a tendency to stain darkly. The stigmatic surface consists of a single layer of finger-shaped cells, darkly staining and lacking cuticle, which stand out separately from one another. Figure 1 (pl. VIII) would appear to show more than one layer of such cells; this appearance results from slightly oblique sectioning. This stigma is histologically quite similar to those of *Sarcodes, Pterospora, Pleuricospora,* and *Newberrya.*

The stout hairs just below the stigma seem to act as a basket for accumulating pollen grains, and may be of some effect in preventing self-pollination, as the anthers in the same flower do not extend above them. Pollen tubes, faintly stained, can be followed from the pollen grains in among the finger-shaped cells of the stigmatic surface, but not definitely any farther. Certain elongate darkly staining bodies seen among the cells of the style may or may not be their advancing tips.

The ovules in my material (pl. VIII, figs. 2, 3) are poorly fixed and are all in a brief range of stages from just before to just after fertilization. They show perfectly standard stages of erical embryology. The ovule has an integument of about two layers of cells; the nucellus has been absorbed and the embryo sac is of the normal type. Figure 2 (pl. VIII) appears to show the penetration of a pollen tube: the two synergids have become flattened against the inner surface of the integument; the pollen tube extends between them and beyond them, within the egg cell, toward the egg nucleus. Figure 3 (pl. VIII) shows the two-celled endosperm; the four-celled endosperm has also been seen.

Discussion and Conclusions

Pityopus is, of all plants known, the one most closely related to *Hypopitys;* the relationship between the two groups is even closer than that between *Hypopitys* and *Monotropa uniflora.* The genus *Newberrya* stands not far from those already mentioned; *Pleuricospora* is more distant. Placentation may be a useful character in constructing keys to the genera of monotropoid plants; it is not usable in gathering these genera into natural groups.

The anatomical peculiarity of the receptacle (describable as consisting of the intercalation of a whorl of bundles, to which the staminal bundles are adnate and which lie outside of the proper pistillar bundles) is of no great theoretical significance.

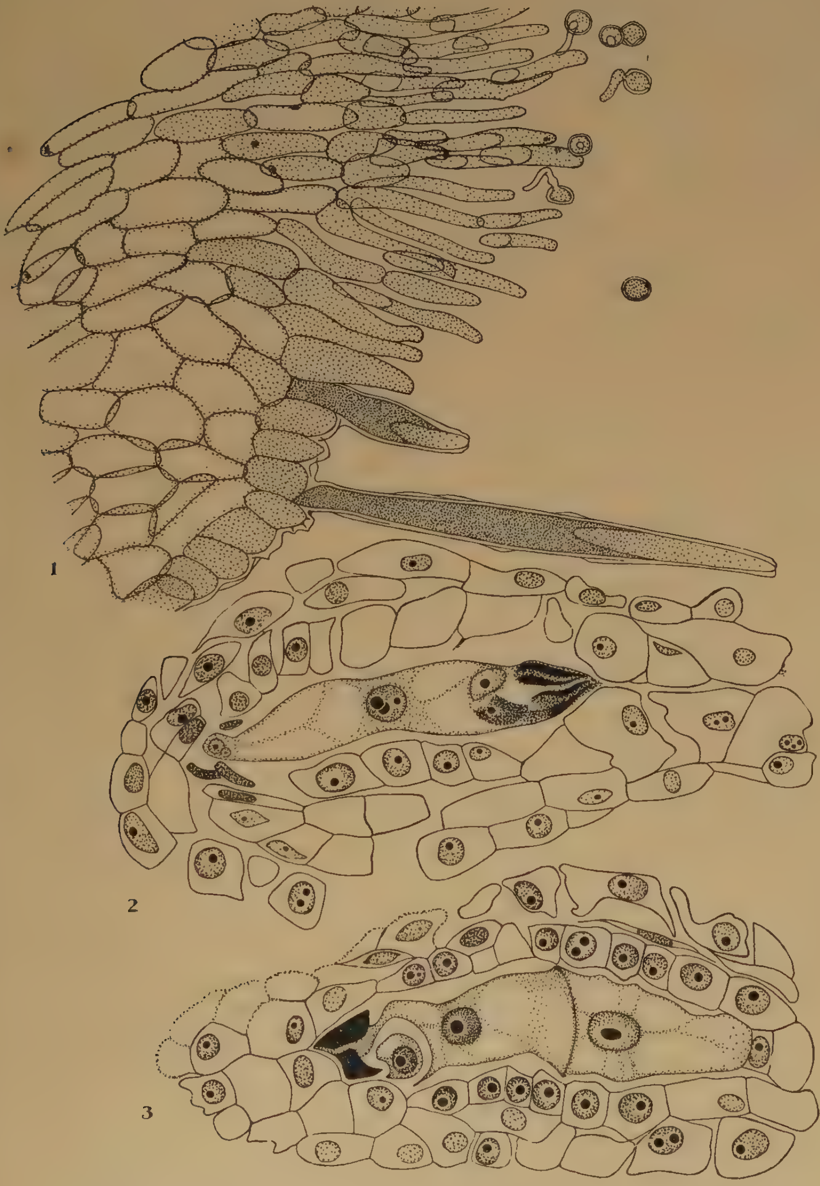

Plate VIII. Fig. 1. Longitudinal section of the edge of the stigma × 200. Fig. 2. Ovule showing fertilization (?) × 400. Fig. 3. Ovule showing two-celled endosperm × 400.

This character is almost certainly not primitive, but something which has appeared in a small derived group.

While consistently treating *Pityopus* as a proper taxonomic group, I have been struck with the possibility that it is not. This uncertainty rests on the following combination of facts: the plant differs from *Hypopitys* in only one essential character, namely, parietal placentation; the two specimens most carefully studied—those of Quick and of Mrs. Richardson—are definitely not alike in inflorescence and number of placentae; the occurrence of the plant is sporadic, and confined to a region where other monotropoid plants are not uncommon. Quick collected it in association with *Pleuricospora,* and Mrs. Richardson, as Henderson noted, "with *Hypopitys, Allotropa,* and later with *Newberrya.*" These facts are consistent with the possibilities, either that *Pityopus* is a repeatedly appearing mutant of *Hypopitys* or else that it is a hybrid. For the present, *Pityopus* is to be regarded as a valid genus; but more data are desirable.

Sacramento Junior College,
Sacramento, California,
March, 1935.

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A NOTE ON SALVIA

Carl Epling

During the course of a recent expedition into Lower California the author had ample opportunity to study over a wide range that sage described by Munz as *Salvia mellifera* var. *Jonesii,* based upon a specimen collected near Ensenada, and known only from a few indifferent herbarium specimens. The species is amply distinct, and I take pleasure in associating with it the name of Dr. Philip Munz, whose excellent treatment of the Californian species of Salvia is well known.

Salvia Munzii sp. nov. per specim. in California inferiore in angustiis apertis prope Hamilton Ranch a Epling et Robison lectum constituta est; typus in herb. Univ. Calif. (Los Angeles) depositus est.

S. mellifera var. *Jonesii* Munz, Bull. S. Calif. Acad. Sci. 26: 24. 1927 per specim. in California inferiore prope Ensenada a Jones (10–IV–1882) lectum constituta est; typum in herb. Coll. Pomonae vidi.

Frutex globosus pulcher 0.5–2.5 m. altitudine ramulis plerumque appresso-hispidulis; foliorum laminis imprimis obovato-oblongis maximam partem 12–40 mm. longis, in apice rotundatis in basi ad petiolos 1–3 mm. longos angustatis frequenter sessilibus, pagina superiore bullulata, hirtclla, inferiore pilis minutis appressis induta ambobus cinereis, marginibus crenulatis; floribus paucis in glomerulis 10–20 mm. diametro dispositis, bracteis saepius oblongo-ellipticis appressis vel acutis vel breviter aristatis ciliolatis caeterum fere glabris subtentis, in spicis simplicibus moniliformibus gracilibus instructis; calycibus florentibus 4.5–6 mm. longis extus hirtellis plus minusve glandulosis, inferioris labiae laciniis 1.5–2 mm. longis subaristatis liberis, superioris omnino conjunctis in apice saepius obscure trimucronatis; corollarum pulchre caerulearum tubo 7–9.5 mm. longo, intus supra medium puberula vix tamen annulato, labia superiore 2–2.5 mm. alta retusa, inferiore duplo longiore; staminibus sub labiam superiorem ascendentibus inter tubi medium et fauces positis quam labia brevioribus e tubo circiter 2 mm. exsertis, connectivo filamentum subaequante.

This handsome species ranges from San Miguel Mountain in San Diego County at least as far south as Rosario and about 25 miles inland from that point, apparently falling within the range of *Rhus laurina.* It ranges from sea level to perhaps 4000 feet, entering the Idria belt of central Lower California. North of Ensenada, at least along the coast, it is spasmodic in occurrence. Southward it becomes more abundant and in the vicinity of San Antonio Canyon is, with *Artemisia californica,* a co-dominant. For miles the hills were blue with its bloom. Its most constant associate throughout this range is *Artemisia californica.*

In odor it resembles *Salvia Clevelandii,* which it also resembles in foliage. It may be readily distinguished from *Salvia mellifera* by its more compact habit, unbranched inflorescence, the more obovate and smaller leaves and particularly by the conformation of the corolla and stamens which are sometimes scarcely exserted from the corolla tube. Its corollas are uniformly a darker blue. Its flowering period is notably earlier than that of *Salvia mellifera,* it being in full flower throughout its range in the first part of February. Some bloom apparently holds on, however, until as late as June. I do not believe that it comes in contact with *Salvia mellifera.* It does, however, frequently meet *Salvia apiana* and at one such point, on the Sacaton road north of San Vicente, a plant was found, not in flower, which suggested strongly a hybrid with that species. A transplant was made but did not survive.

University of California at Los Angeles,
July, 1935.

NEW OR OTHERWISE NOTEWORTHY NORTH-WESTERN PLANTS—I

Lincoln Constance and Louis A. Dillon

Under the heading, "New and Noteworthy Northwestern Plants," Dr. Charles Vancouver Piper, while associated with the State College of Washington, initiated a series of botanical notes dealing with the flora of the Pacific Northwest. The first of these articles appeared in Erythea in 1896 and subsequent papers are to be found in the same journal and in the Bulletin of the Torrey Botanical Club.

This title was revived by Dr. Harold St. John when he was in charge of systematic botany at this institution and he and his students used it as a medium for the publication of a number of novelties between 1928 and 1930. This series has lapsed during the past several years, but it is the intention of the present staff of the Herbarium of the State College to renew it (under the slightly modified title at the head of this article[1]) as a vehicle for the publication of critical notes, new distributional data, and the description of new forms.

Since the flora of the Pacific Northwest is of interest alike to systematic botanists and to students of floristic distribution, we feel that any interesting items turned up during study in this herbarium should be made generally available. Of some species, we have uncovered older collections than the ones on

[1] Contribution No. 45 from the Botany Department of the State College of Washington.

which certain published "first records" for Washington are based, and we feel that these facts should be made known.

AGROSTIS INTERRUPTA L. Through the assistance of Mrs. Agnes Chase, of the Bureau of Plant Industry, we are enabled to make a report concerning this relatively recent introduction from Europe. The species was placed in the genus *Apera* by Beauvois, but we find *Agrostis interrupta* to be preferable, and this is the name adopted by Dr. Hitchcock for his forthcoming manual. With the possible exception of a specimen from St. Louis deposited in the Herbarium of the Missouri Botanical Gardens, the first authentic collection in the United States was made by T. A. Bonser in 1922. With this and later collections in this state, we offer the following list:

WASHINGTON. In depression in prairie, near Lidgewood, Spokane Co., June 3, 1922, *T. A. Bonser;* gravelly loam, in a small kettle left by glacier, Spokane Valley, June 5, 1925, *T. A. Bonser 3;* dry alkaline flat 3 mi. N. W. of Ewan, Whitman Co., June 7, 1934, *F. L. Pickett, J. F. Clarke & L. A. Dillon 1612.*

Two other collections have been made in the Pacific Northwest,[2] the Hutchinson specimen representing the first North American material:

BRITISH COLUMBIA. Okanogan River Basin, Vernon, June 17, 1918, *A. H. Hutchinson 3.*

OREGON. Ballast, Linnton, Portland, Multnomah Co., June 16, 1925, *W. N. Suksdorf 3356.*

ERAGROSTIS CILIANENSIS (All.) Link. This introduced European grass, reported from several stations in California, has also appeared in the State of Washington. This new record we owe to Mr. George Neville Jones of the University of Washington who identified one of the following collections and noted its novel character:

WASHINGTON. Rocky coulee, east of Whitstran, Benton Co., Oct. 7, 1929, *Leslie Smith 265;* Richland, Benton Co., November, 1931, *Mrs. E. F. Gaines.*

TRILLIUM PETIOLATUM Pursh. In his "Notes on the Flora of the State of Washington—II" (5) Thompson records his no. 6444, obtained in 1931, as the first collection of this species from the central part of the state. His collection is antedated by the following:

WASHINGTON. Moist meadow near road, Leavenworth, Chelan Co., May 18, 1928, *H. St. John, W. W. Eggleston, R. G. Beals & F. A. Warren 9484.*

BASSIA HYSSOPIFOLIA (Pall.) Kuntze. Tidestrom mentions this chenopodiaceous plant as occurring in "Waste places; near U. S. Experiment Station, Fallon, Nevada. Introduced from western Asia" (6, p. 178). Apparently the species has not been included

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[2] Since this paper was written, the following additional locality has been cited in A. S. Hitchcock's recently published Manual of the Grasses of the United States: "Idaho (Nezperce Forest)."

in any other North American flora. In habit it approaches *Dondia* and related genera, but may be easily distinguished by the presence of conspicuous hooked appendages on the calyx. The species has recently appeared as an adventive weed in Benton and Okanogan counties and may now be added to the flora of the state:

WASHINGTON. Alkali ground, Prosser, Benton Co., Sept. 2, 1929, *Leslie Smith 104;* growing in strong alkali ground along highway between Omak and Okanogan, Okanogan Co., Sept. 15, 1933, *Chas. B. Fiker 1426;* generally, in orchards and along highway near Tonasket, Okanogan Co., Sept. 8, 1934, *F. L. Pickett 1673.*

SAXIFRAGA OPPOSITIFOLIA L. Although this attractive alpine plant has long been known to occur in Alaska, British Columbia, and Wyoming, it has, apparently, never been reported from this state. A collection made by Mr. Helmrich in the Olympic Mountains and distributed by Mr. J. W. Thompson will doubtless be published by the latter, but the station noted below is so far removed from the Olympic Peninsula that it is also worthy of record:

WASHINGTON. Limestone ledges, alt. 4000 ft., Twin Lakes, Winchester Mountain, Whatcom Co., Sept. 7, 1927, *H. St. John 8937.*

ASTRAGALUS ALPINUS (L.) Sheldon and A. MACOUNII Rydberg. *Astragalus alpinus* was first reported (under *Phaca*) from the State of Washington by Piper (2, p. 371), on the basis of a single collection by Whited, in Okanogan County. No additional localities have been reported from the state. *A. Macounii* was stated by M. E. Jones (1, p. 135), who treated it as *A. labradoricus* DC. var. *occidentalis* (Wats.) Jones, to occur "as far westward as Upper Marias Pass in Montana and Oroville [Okanogan Co.] in the Cascades, Washington." This species was later collected, also in Okanogan County, by Eggleston.

This herbarium has recently received several specimens of *Astragalus,* section *Atelophragma,* from the same part of the state, and the attempt to identify them has led to a re-examination of the old material assigned to these two species, as well as to an intensive study of the new. The species are not dissimilar in general characteristics, except that *Astragalus Macounii* is larger in most structures. In fact there seems to be considerable confusion of opinion as to what the distinguishing characters are. Apparently, the truly critical difference is to be found in the morphology of the pod of the two species. *Astragalus Macounii* has a pod in which neither suture is sulcate, but the dorsal (upper) has a narrow inflexed edge. In *A. alpinus* the ventral (lower) suture is sulcate, while the dorsal has no intrusion whatsoever. Segregation of the specimens at hand on this basis shows that Whited's specimen has heretofore been assigned to the wrong species and is actually *A. Macounii.* Since this has

been the only specimen to substantiate the occurrence of *A. alpinus* in Washington, the following recent collection constitutes the first authentic record reported for the state:

WASHINGTON. Moses Meadows, Okanogan Co., July 4, 1933, *Chas. B. Fiker 1222.*

As material of *Astragalus Macounii,* we may now list the following:

WASHINGTON. Damp thicket, Conconnully [Okanogan Co.], July 22, 1900, *K. Whited 1307;* Tamarack Camp, above Hidden Lakes, Okanogan Forest, Okanogan Co., 2150 m., Aug. 8–10, 1916, *W. W. Eggleston 13440;* flowers lavender, open woods, Riverside, Okanogan Co., July 1, 1933, *H. St. John 7721;* near swamp in damp ground near summit Tonasket-Republic highway, alt. 4000 ft., July 4, 1934, *Chas. B. Fiker 1521.*

OXYTROPIS DEFLEXA (Pall.) DC. In his recent paper, "A Revision of the Loco-weeds of Washington" (3), St. John allowed a total of five species for the state, four of which were new. It is due to the energetic efforts of an enthusiastic amateur collector of north central Washington, Mr. Charles B. Fiker, that we are now able to add another species to this list. All of the species credited to the state by St. John fall into the section *Campestres* of Rydberg's treatment in his Flora of the Rocky Mountains, while *O. deflexa* belongs to the section *Deflexi,* distinguished by conspicuously pendent pods. The specimen is, we believe, the first record of the species west of the Rocky Mountains, and represents a very remarkable extension in range:

WASHINGTON. In an abandoned field one mile north of Old Waucanda, Okanogan Co., Aug. 18, 1933, *Chas. B. Fiker 1389.*

HYOSCYAMUS NIGER L. In an earlier paper, Thompson (4) has recorded his 1931 collection of this species in Okanogan County as the first record and station for the state. Among the unidentified material in the Herbarium of the State College was discovered the following, collected eight years earlier:

WASHINGTON. Abundant in old sawmill clearing, Riverside, Okanogan Co., July 1, 1923, *H. St. John 7723.*

Herbarium of the State College,
Pullman, Washington,
March 4, 1935.

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ITINERARY OF YNES MEXIA IN SOUTH AMERICA

Mrs. H. P. Bracelin

A brief summary of the itinerary of Mrs. Ynes Mexia during her recent collecting expedition to Brazil and Peru is herewith presented. Such a record, it is believed, will prove useful to botanists in various institutions who engage in the study of the plants. All data are taken from the collector's field books.

The actual collecting period was from November 15, 1929 to February 10, 1932. The collections are numbered serially from 4001 to 6518. In many cases a letter was added for further segregation (4001a, 4001b, etc.). The total number of specimens in the collection, including duplicates, amounts to more than sixty thousand.

From Rio de Janeiro, the port of arrival, Mrs. Mexia proceeded to the state of Espiritu Santo, a short distance northward up the coast. The first objective was the ascent of Caparaó, a mountain lying on the boundary line between the states of Espiritu Santo and Minas Geraes. Collections were made in this general vicinity and during the ascent of the mountain. Mrs. Mexia then returned to Rio de Janeiro and from there proceeded northward to the interior highlands. She established headquarters at the Agricultural College at Viçosa where she remained for more than a year in order to make representative collections at all seasons. She next visited Diamantina, the classic collecting ground of Martius, two hundred miles north of Viçosa. Returning to Rio de Janeiro, she embarked on a coastwise steamer for the mouth of the Amazon. One stop was made en route at Cabedelo in the state of Parahyba. At Pará, the capital of the state of the same name, two months were devoted to collecting.

Mrs. Mexia then embarked for Iquitos, Peru, twenty-five hundred miles up the Amazon. Many short stops were made by the wood burning steamer for refueling and other purposes, and at two of these, in the state of Amazonas, a few numbers were collected. On September 20, 1931, the twenty-fourth day of the voyage, the boat arrived at Iquitos. Here preparations were made for continuing the voyage to the head of navigation of the Amazon. Securing a native guide and two "civilized Indian" helpers, Mrs. Mexia ascended Rio Marañon by launch and canoe to Pongo de Manseriche, the great gorge of the Amazon. Having established headquarters a few miles above the gorge, she devoted the next three months to collecting. This region is uninhabited except by the nomadic Aguaruna Indians. The return journey down the river was made on board a raft constructed by one of the guides. After collecting in the vicinity of Iquitos, Mrs. Mexia crossed the Andes by plane and, finally

arriving at Lima on the west coast, embarked for the United States.

Sets of the Mexia South American collections are deposited in the following institutions: UNITED STATES: Academy of Natural Sciences, Philadelphia; Arnold Arboretum, Mass.; California Academy of Sciences, San Francisco; Catholic University of America, Washington, D. C.; Field Museum of Natural History, Chicago; Gray Herbarium, Harvard University; Missouri Botanical Garden, St. Louis; New York Botanical Garden; United States National Museum, Washington, D. C.; University of California, Berkeley; Wellesley University, Mass. EUROPE: Botanical Museum, Copenhagen; Botanischer Garten und Museum, Berlin-Dahlem, Germany; British Museum; Conservatoire et Jardin Botaniques, Geneva; Muséum d'Histoire Naturelle, Paris; Naturhistoriska Riksmuseet, Stockholm; Royal Botanic Gardens, Kew; University of Zürich.

Following are the localities where collections were made, together with dates and corresponding collection numbers.

RIO DE JANEIRO, BRAZIL

Rio de Janeiro. Nov. 15, 1929, 4001–4002; June 14, 1930, 4786; June 1, 1931, 5901–5903.

ESPIRITU SANTO, BRAZIL

Serra do Caparaó, Santa Barbara do Caparaó and Alegre. Nov. 20, 1929 to Nov. 25, 1929, 4003–4027; Nov. 27, 1929, 4033; Nov. 29, 1929 to Dec. 7, 1929, 4038–4107.

MINAS GERAES, BRAZIL

Serra do Caparaó. Nov. 26, 1929, 4028–4032 and 4034–4037.

Viçosa. Dec. 16, 1929 to Jan. 10, 1930, 4108–4217; Feb. 10, 1930 to Apr. 28, 1930, 4335–4650; May 10, 1930 to June 7, 1930, 4678–4689a and 4691–4785; June 24, 1930 to Sept. 10, 1930, 4787–4950; Sept. 11, 1930 to Oct. 16, 1930, 5030–5185; Oct. 16, 1930 to Oct. 24, 1930, 5215; Oct. 25, 1930 to Oct. 28, 1930, 5220–5226; Oct. 29, 1930 to Nov. 4, 1930, 5233–5249; Nov. 4, 1930 to Nov. 5, 1930, 5256–5258a; Nov. 6, 1930 to Nov. 12, 1930, 5265–5292; Nov. 17, 1930 to Nov. 24, 1930, 5309–5350; Nov. 26, 1930, to Dec. 20, 1930, 5357a–5429a; Dec. 22, 1930 to Dec. 27, 1930, 5431–5454a; Dec. 29, 1930 to Jan. 2, 1931, 5459–5472; Jan. 5, 1931 to Jan. 7, 1931, 5481–5487; Jan. 8, 1931, 5488a; Jan. 9, 1931, 5496a–5500; Jan. 15, 1931, 5496a.

Districto Carangola. Jan. 25, 1930 to Feb. 6, 1930, 4218–4334; May 12, 1931, 4690.

Districto Viçosa. May 2, 1930 to May 6, 1930, 4651–4677a; May 12, 1930, 4690.

Districto Ilheu. Aug. 15, 1930 to Aug. 31, 1930, 4951–5029.

Districto Dante. Aug. 25, 1930, 4999a.

Districto Casca. Aug. 28, 1930, 5011a–5017.

Districto Rio Branco. Oct. 16, 1930, 5186–5187; Oct. 24, 1930, 5216–5219; Oct. 28, 1930, 5227–5232; Nov. 4, 1930, 5250–5255; Nov. 6, 1930, 5259–5264; Nov. 13, 1930 to Nov. 14, 1930, 5293–5308; Nov. 25, 1930, 5351–5357; Nov. 28, 1930, 5375; Dec. 19, 1930, 5430; Dec. 27, 1930, 5455–5458; Jan. 2, 1931 to Jan. 3, 1931, 5473–5480; Jan. 8, 1931, 5488–5496.

Districto Corinto. April 1, 1931 to April 22, 1931, 5501–5700.

Diamantina. Apr. 28, 1931 to May 2, 1931, 5701–5743; May 4, 1931 to May 15, 1931, 5749–5818a; May 14, 1931 to May 16, 1931, 5834–5857a.

Districto Diamantina. May 3, 1931, 5744–5748; May 13, 1931, 5819–5833; May 19, 1931 to May 21, 1931, 5858–5900.

PARAHYBA, BRAZIL

Cabedelo. June 18, 1931, 5905–5906.

PARÁ, BRAZIL

Districto Belém. June 29, 1931, 5907–5913; Aug. 16, 1931, 6064–6065.
Districto Acará. July 16, 1931 to Aug. 6, 1931, 5914–6063.
Districto Jurutý. Sept. 2, 1931, 6066.

AMAZONAS, BRAZIL

Ilha das Oncas. Sept. 3, 1931, 6067–6068.
Rio Solimoes. Sept. 10, 1931, 6069.

DEPARTAMENTO LORETO, PERU

Yurimaguas. Oct. 24, 1931 to Oct. 26, 1931, 6070–6089; Dec. 1, 1931, 6101–6129.

Above Pongo de Manseriche. Nov. 13, 1931 to Nov. 28, 1931, 6132–6184a; Nov. 29, 1931 to Dec. 13, 1931, 6191–6267; Dec. 18, 1931 to Jan. 3, 1932, 6290–6381.

Sierra del Pongo. Nov. 29, 1931, 6185–6189; Dec. 15, 1931, 6268–6289a.

Below and in Pongo de Manseriche. Jan. 5, 1932, 6382–6383.

Alto Marañon. Jan. 11, 1932, 6384a.

Distrito Iquitos. Jan. 20, 1932 to Jan. 29, 1932, 6385–6475; Feb. 2, 1932, 6476; Feb. 6, 1932 to Feb. 10, 1932, 6477–6518.

Berkeley, California,
April, 1935.

A NEW CARDAMINE FROM NORTHERN IDAHO

LEROY E. DETLING

Cardamine Constancei sp. nov. Planta glabra, perennis; rhizomate ramoso, diametro 2 mm. vel minus; caule 15–30 cm. alto, erecto, simplice, infere purpurascente; foliis 4–7, plerumque parte media superave caulis approximatis, simplicibus, ovatis, 3–8 vel 10 cm. longis, grosse serratis vel rarius undulatis, petiolatis; racemo pauci-floro; pedicellis 10–17 mm. longis; sepalis 6 mm. longis, margine scarioso; petalis roseis, in sicco purpurascentibus, 20–25 mm. longis, unguiculis laminis fere aequantibus; siliquis maturis ignotis.

Glabrous perennial from a branching rootstock not exceeding 2 mm. in diameter; rhizomal leaves none; flowering stem 15–30 cm. high, erect, unbranched, purplish below; leaves 4–7 in number, mostly crowded together at the middle or upper part of the stem, ovate, 3–8 or 10 cm. long, the margins coarsely serrate or less frequently merely undulate, on petioles 5–20 mm. long; raceme few-flowered; pedicels 10–17 mm. long; sepals 6 mm. long, scarious-margined; petals pink, drying purplish, the blade

PLATE IX. CARDAMINE CONSTANCEI DETLING: TYPE SHEET

6–8 mm. wide and 10–12 mm. long, the narrow claw about as long as the blade; mature fruits not seen.

"Humus soil under Abies-Thuja climax, [Canadian Zone], 4 mi. below Lowell, on Three Devils Creek, at Middle Fork of Clearwater River, Selway National Forest, Idaho County, Idaho." *L. Constance, R. Rollins, A. Dimond* and *C. Worley 1108,* June 2, 1935. Type specimen in the Dudley Herbarium at Stanford University, California; specimen sheet No. 229378.

This species is strikingly different from any other American form of *Cardamine.* In general habit it is very suggestive of certain species of *Dentaria* on account of the extraordinarily large pink flowers and the leaves which are mostly clustered not far below the inflorescence. But the slender rootstock and the total absence of rhizomal leaves must clearly exclude it from the latter genus.

The name is given in appreciation of the efforts of Dr. Lincoln Constance of the State College of Washington in obtaining and forwarding a large number of specimens.

Stanford University,
July, 1935.

NOTES AND NEWS

Under a Fellowship of the John Simon Guggenheim Foundation of New York, Dr. T. H. Goodspeed, Professor of Botany and Director of the Botanic Garden of the University of California at Berkeley, will spend the months from October, 1935 to February, 1936 collecting specimens of *Nicotiana* and related genera in Peru, Chile, Bolivia, and Argentina. Mr. James West of San Rafael accompanies Dr. Goodspeed as collector. At Lima Mrs. Ynes Mexia, now collecting in Ecuador, will join the expedition. Most of the collecting will be done at higher altitudes of the Andes, but it is anticipated that certain members of the expedition will travel six hundred miles south of Santiago de Chile, crossing the Andes in the lake region and continuing through the Patagonian pampas to Buenos Aires. The expedition has been authorized by the regents of the University of California, and has been made possible by the grant from the Guggenheim Foundation, and by the assistance of the Huntington Botanical Garden of San Marino, the Bureau of Plant Introduction at Washington, D. C. and friends of the Botanical Garden.

Contributions to Western Botany Number 18 by Marcus E. Jones has recently been received. This, the closing number of a series begun forty-four years ago in Zoe, contains 157 pages of text and many illustrations including portraits of well known botanists. Over one-third of Number 18 is devoted to taxonomic notes. One new genus, Hutchinsonia (Compositae), and about

140 new species, mainly of Mexican plants, are described. These cover a wide range of families, Leguminosae, Euphorbiaceae, and Compositae predominating. There is a very readable account of a collecting trip in 1930 to Lower California. Articles of historical and biographical interest are: Modern and Early Botanizing; How I Became a Botanist; Botanists I Have Known; and the biographical sketch of Mr. Jones by his daughter, Mabel Jones Broaddus. Two excellent portraits of Mr. Jones introduce the number. Pages 30 to 85 of Number 18 appeared August 23, 1933; pages 86 to 131 were printed and a limited number of copies distributed by Mr. Jones before his death on June 3, 1934. His manuscripts for the remaining pages were edited and published by his daughter, Mabel Jones Broaddus, the first copies being mailed August 12, 1935.—E. Crum.

Mr. J. W. Stacey, 236 Flood Building, San Francisco, California, is preparing a monograph on Carices of the eleven western states and would be very glad to have the loan of critical, or undetermined material from this region. He would be glad also to exchange duplicate specimens of *Carex* from the western states or from any other part of North America. Correspondence is invited.

Dr. and Mrs. Harold E. Bailey of the Department of Botany, University of California, Berkeley, left May 20 for Grand Canyon National Park. Dr. Bailey has accepted a position as Assistant Forester in the National Park Service. With two assistants, he will carry on field work for the Vegetation Type Maps which are being made for the several parks. During the next six months, this work will take him to Grand Canyon, Grand Tetons, Mount Rainier, and Crater Lake national parks.

A contribution of outstanding interest to western botanists, "The North American Species of Sphaeralcea Subgenus Eusphaeralcea" by Thomas H. Kearney, has recently been issued (Univ. Calif. Pub. Bot. 19: 1–128, pls. 1–12. 1935.). This paper constitutes a comprehensive treatment of a group of plants with a center of diversity in southwestern North America. Four subgenera are recognized of which only the first is treated. As here interpreted the subgenus Eusphaeralcea comprises twelve sections containing a total of twenty-seven species. In the introduction there is a discussion of the range of variation in the subgenus and in the specific groups. Keys to subgenera, sections, species, and subspecies are worked out in detail. The text is accompanied by twelve excellent plates in which carpel configuration in the different species is especially emphasized. The author has dealt with the complex problem of specific limits in this actively evolving group in a practical and conservative manner.—E. Crum.

The United States Department of Agriculture has recently issued a "Manual of the Grasses of the United States" by A. S. Hitchcock, as no. 200 of its Miscellaneous Publications. Keys, descriptions, and range of distribution are given for the grasses of continental United States, exclusive of Alaska. These number some 1100 species of which 151 are reported introduced. Illustrations are included for practically all the species, and the distribution of many is graphically shown on small maps. In the introduction are included notes on the uses, distribution, morphology, classification, and nomenclature of grasses. An exhaustive synonymy follows the systematic treatment. A glossary and a roster of persons for whom grasses have been named completes the volume of over one thousand pages. The manual will certainly prove of interest and utility to botanists in general, and indispensable to the agrostologist.

Dr. G. Ledyard Stebbins, Jr., who received the degree of Ph.D. from the Laboratory of Plant Morphology and Cytology of Harvard University in 1931, and since then has been Instructor in Botany and Biology at Colgate University, Hamilton, New York, has taken the position of Junior Geneticist in the California Experiment Station, University of California, Berkeley. He will be engaged for three years as assistant to Professor E. B. Babcock of the Division of Genetics in a taxonomic, cytological, and phylogenetic study of Prenanthes, Lactuca and related genera.

Mr. Raymond Fosberg of the Department of Botany of the University of Hawaii arrived at the University of California, Berkeley, August 31, 1935, to consult the herbarium in connection with his research work. He left on September 21 to resume his duties.

Dr. Harold St. John of the Department of Botany, University of Hawaii, is on leave during the college year, 1935–1936. He is at present in Europe where, after attending the Sixth International Botanical Congress at Amsterdam, he will spend several months at the herbaria at Berlin and at Kew and will make shorter visits to those of Vienna and Prague. After returning to the United States, he will visit some of the leading botanical institutions before returning to Hawaii in the autumn of 1936.

Botanists of San Francisco Bay region who attended the Sixth International Botanical Congress at Amsterdam are: Miss Alice Eastwood and Mr. John Thomas Howell of the California Academy of Sciences; Professor D. R. Hoagland, Dr. W. L. Jepson, and Dr. W. A. Setchell of the Department of Botany of the University of California.

THE PRINCIPLES OF GEOGRAPHIC DISTRIBUTION AS APPLIED TO FLORAL ANALYSIS

Herbert L. Mason

In attempting to analyze the present flora of California in terms of its history and floristic relationships many problems of interpretation and procedure present themselves, which call for a study of the dynamic processes that have governed the distribution of plants throughout the long history of the spermatophytes. The results of these studies have been the building up of certain dicta that seem for the present, at least, to serve as a working hypothesis from which strides can and have been made toward this original objective of the problem. Although this goal has not as yet been reached, it seems desirable to place on record at the present time the basic principles arrived at, that they may serve to stimulate discussion and thereby, it is hoped, clarify the point of view and bring to the subject the thoughts and opinions of others working in this field.

In the light of paleobotanical evidence, it is not possible to regard the flora of California solely as a phytogeographical unit occupying a biogeographical province whose major characteristics are largely the expression of the climatic differences of a varied topography. Instead, it must be regarded as the product of the bringing together and sorting out of many floristic units, derived from several sources, which have accommodated themselves to new social alignments which are expressed by the present flora of California as we now see it in more or less apparent climatic balance.

Proceeding on the assumption that floras in general are the product of complex processes of floristic evolution, we may attempt to analyze them in terms of their particular origins. This evolution of floras not only involves the organic evolution of morphological and physiological characters of the plants, but also the intricacies of migration. The climatic changes causing migration also bring about selection and segregation of species and permit the intermingling of previously unassociated plants. These intricate dynamic processes have so complicated the floras of the world that on the basis of the distributional features of the modern representatives of the floras alone any inferences as to their movements are likely to be superficial except in certain very obvious cases. Our most reliable source of information, however incomplete, is the fossil record left in beds whose position in the geological sequence can be correctly ascertained and correlated with other plant-bearing deposits. There must also be recorded in these deposits plants whose taxonomic status is unquestionably determinable, a problem increasingly difficult as we go backward into the geological record and one calling

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for extreme caution in its interpretation. Only then can we speak with any reasonable degree of certainty of the time and space sequence in the movement of floras and their significance in the interpretation of climate.

R. D'O. Good (3), dealing with the problems of angiosperm geography, outlined for this group of plants what he termed the "Principles" governing their distribution. He brought together, in a logical sequence, the obvious incontestable truths that have guided botanists in the past in their deductions but which had never before been assembled as a unified working hypothesis. The purpose of Good's work, as stated, was to arouse interest in the subject that we might construct a proper scientific foundation upon which to build our ideas of plant distribution. Good's principles, on the whole, need to be amplified to make them more precise in their application. They deal only with general dicta pertaining to the environment and to migration without considering adequately—except as the Theory of Tolerance might be applied—the responses of the plant and the perpetuation and evolution of floras. These subjects, in the opinion of the writer, are of sufficient importance to justify their inclusion in the principles of plant geography.

In the following pages there is recorded a series of principles, some of which are accepted as stated by Good, others are amplified to make their application more precise, while several new proposals are presented for the consideration of plant geographers. It is not intended that the problems of plant geography be considered as settled here; much cooperative thought and research must still be expended before even the basic principles of this vast subject can be expressed in final form. The present ideas are the results of ten years of study of the problems of distribution of the California flora and have been gained from observations of the modern plants and of the fossil records as they have revealed the story of the migrational history and floristic evolution of the component parts of this flora over an area extending from Point Barrow, Alaska, to Mexico, and eastward through the Rocky Mountains, a region containing one of the most complete Tertiary plant records available to the world.

The principles here presented are organized under four headings. The first deals with the general subject of the environment in a dynamic sense, including the factors of the environment and the physical basis for their modification and control. The second group deals with the responses of the plant as governed by the Theory of Tolerance and the Principle of Limiting Factors. The third group is concerned with migration and establishment, and the fourth group deals with the perpetuation of vegetation and the evolution of floras. The word distribution is used herein only to imply the area of occupancy and not dispersal.

I. The Environment of the Plant

1. *Plant distribution is primarily controlled by the distribution of climatic factors and in any given region the extremes of these factors may be more significant than the means.*

This is a restatement of Good's first principle with the limitation clause involving the extremes added. That plant distribution is primarily controlled by climatic factors seems obvious when considered in terms of the floras of the various climatic zones. That the extremes of climate are more significant than the means may require an explanation. The occasional year or occasional season, wherein a critical factor is in excess of the tolerance of a species for that factor, often demonstrates in a striking way the importance of the extreme as a limiting factor in distribution. For a long time we were puzzled by the failure of the redwood to move northward into what appeared to be a favorable terrain. There seemed to be little in the way of climatic factors operating to prevent it, since trees transplanted, even as far north as British Columbia, grew well.

In the winter of 1932 abnormally low temperatures were experienced in California. McGinitie (6) observed that throughout the northern range of the redwood all the new growth was materially affected by freezing. These low temperatures are much more prevalent in the coastal regions to the north and although the mean varies little northward, such extremes are reached often enough over a period of years to prevent establishment and hence migration. This is clearly a case of the extreme being the controlling factor. W. P. Taylor (8), in dealing with problems in zoology, as they were observed to affect distribution and functioning during the cold winter of 1932 on the one hand and the drought of the summer on the other, noted the imporance of this factor in conjunction with a critical time. Taylor was impressed by the effects of extreme climatic conditions which are wholly abnormal and which occur rarely to occasionally. He noted that such occurrences had very profound biological effects and in some instances wiped out certain species or so weakened them that they were the ready prey of their enemies. According to Taylor, the importance of these extremes necessitates a restatement of Liebig's law (4) so as to bring in a concept of the critical time. His rewording of Liebig's law is as follows, "The growth and functioning of an organism is dependent on the amount of the essential environmental factor presented to it in minimal quantity during the most critical season of the year, or during the most critical year or years of a climatic cycle."

2. *Plant distribution is secondarily controlled by the distribution of edaphic factors.*

Obviously such control of distribution as is exercised by edaphic factors is conditioned by climate, both in respect to

aerial climate and with respect to the climatic factor in soil decomposition and upbuilding. The achievement of the climax vegetation in the succession of a hydrosere or a xerosere is accomplished by the progressive subjugation of the original edaphic complex. Even in such highly specialized cases as large areas of serpentine outcrops with their specially adapted species, the vegetation must first be in accord with climate. It is, therefore, logical to place the edaphic factor as subordinate to the climatic factor.

3. *There has been great oscillation and variation in climate, especially in the higher latitudes during the geological past.*

Whether or not one agrees with Chamberlain (1) in his theory of the alternation of cool, dry, zonal climates and widespread, moist, humid climates, the fossil record reveals that many floras have occupied in the past different positions from those which they now occupy. The Cretaceous floras suggest wide-spread uniformity from Greenland in the Arctics to Grahamland in the Antarctics. This does not necessarily prove the absence of zonal climate in the world during this time but it does demonstrate a general rise in temperature, so that vegetation of an ecological type now confined to a region much farther south was permitted far to the north, as well as to the south of the equator. Climate seems to be the only significant variable that operates from one region to another in a manner which would stimulate the migration of floras.

4. *At least some, and probably considerable, variation has occurred in the relative distribution and outline of the lands and seas in geological past.*

Here again, in spite of debatable theories of horizontal earth movement, the evidence for elevation and subsidence is so strong as to be almost incontestable. Whether one accepts the theory of continental drift of Wegener (9) or adheres strictly to the older ideas of the permanence of ocean basins, concepts of the incursions of epicontinental seas are not materially affected. Both theories permit them and the evidence for their existence and the areas of their occupation is just as convincing in the light of either theory.

This principle, as well as the one dealing with climatic change, provides the mechanism for the control over the climatic and edaphic factors, throughout time, as well as the means for the establishment and removal of barriers to migration.

II. The Responses of the Plant

To understand the workings of geographic principles, it is necessary to go back to the fundamental physiological processes as they apply to the individual plant. The plant as an organism behaves strictly in accordance with orderly physiological laws. The factors of the environment must, in the last analysis, be

interpreted in their effect on specific physiological processes. The physiology of plants is governed, first of all, by the laws of evolution and genetics in delimiting their potential behavior. The range of this potential behavior is the measure of the plant's plasticity or variability, and limits the nature of the responses to varying stimuli. It is in physiological response that we find the mechanism for most of the processes of plant distribution and floral evolution. It is, therefore, important that they be considered in the theories of plant geography.

5. *The functions governing the existence and successful reproduction of plant species are limited by definite ranges of intensity of particular climatic, edaphic, and biotic factors. These ranges represent the tolerance of the function for the particular factor.*

This statement accepts the major thesis of Good's Theory of Tolerance and the Theory of Physiological Limits proposed by Livingston and Shreve (5). It seems better in the generalized statement, however, to restrict the concept of tolerance to a specific tolerance of a specific function, as is done in the Theory of Physiological Limits. The sum of tolerances does not serve a useful purpose; neither is the total span of the tolerances of the various functions for a factor necessarily significant. The most significant tolerance range is the intensity span of the factor during any particular phase of development from the maximum of the critical function having the lowest maximum, to the minimum of the critical function having the highest minimum for the particular factor. This span might be taken as the range of tolerance of the plant for this particular factor, but during this phase only. During another phase of development, the span of tolerance may be either lessened or broadened at one or both of its extremes. This leads directly to the principle of limiting factors, which when applied to plant geography, may be stated as follows:

6. *In the life history of the organism there are times when it is in some critical phase of its development which has a narrow tolerance range for a particular factor of the environment. The distribution of this intensity span of the factor during the time the plant is in this particular phase limits the area in which the function can operate and, hence, governs the distribution of the species. The narrower the range of tolerance, the more critical the factor becomes.*

When we consider the large numbers of seeds that fall in an area and germinate and the small number that establish themselves at least to the point of entering into competition, we may conclude that establishment is a critical phase not only in migration but also in the life history of the individual. The high percentage of elimination of migrules during this critical period suggests that the tolerance range for the factor controlling this establishment is very narrow. So long as the intensity of this factor remains within the range of tolerance of the

species, the plant will become established so far as it is influenced by this factor. If the intensity exceeds the tolerance of the species, establishment will fail, and this factor becomes a limiting one in this phase of the plant's development. With establishment effected, this particular range of the factor is no longer critical or limiting. It is probable that the factors limiting establishment are among the most important of climatic barriers and certainly they play a prominent part in preventing the spread of many exotic species introduced by man. Often in California orchards, fruit is not set when the blooming period coincides with rains or heavy fog. These factors may become limiting because the excess moisture may destroy the pollen or the cloudiness and fog may so retard the activities of insects as to prevent pollination. The blooming period then is the critical phase in the production of fruit. Cloudiness and fog and the same degree of moisture excess are not limiting to other phases of the plant—they may even stimulate them to higher development. Therefore, with respect to these factors, the critical phase of the plant is significant.

III. Migration of Floras

Since it is apparent that migration has been an agent in the development and evolution of floras, it is important that this process have a place among the principles of plant geography.

7. *Great movements of floras have taken place in the past and are continuing to take place.*

The most convincing evidence of past migration of floras is the history of the flora that has been associated with the record of *Sequoia sempervirens*. In tracing the history of redwood in North America, it is necessary to go more deeply into the geological sequence as we go northward. We find it in the Eocene of Alaska and Canada, the Oligocene of Oregon, the Miocene of California and Nevada, and the Pliocene of California, where it became restricted to its present coastal distribution by the close of the Pleistocene. The conclusion is evident that as time progressed, the redwood and its associates moved farther and farther southward.

The revegetation of the glaciated areas of Northern and Eastern North America and the slow retreat of modern glaciers with the populating of the areas they occupied afford evidence that floral migrations are still in progress.

8. *Migration is brought about by the transport of individual plants during their motile dispersal phases and the subsequent establish*ment *of these migrules.*

Migration is not merely the dispersal of seeds or other migrules. It is not effected until establishment is complete, and establishment, since it is limiting to migration, becomes, therefore, the most critical phase of the process. It is necessary then

to modify Good's principle involving migration to include the establishment phase of the problem. The mechanism behind the establishment is the mechanism of stimulus and response wherein particular factors of the environment act upon particular functions of the plant.

IV. The Perpetuation and Evolution of Floras

Were it only the environment and the control exercised over it by diastrophism and subsequent climatic change that played a part in vegetation, extermination of all plants would have been accomplished long ago. The plasticity of the plant species, as well as its mobility, have enabled vegetation not only to persist but to become so modified that one may well speak of such a phenomenon as the evolution of floras.

9. *The perpetuation of vegetation is dependent first upon the ability of the species to migrate and secondly upon the ability of the species to vary and to transmit the favorable variations to their offspring.*

The great oscillations of climate that have occurred in the past caused the species of plants making up the vegetation either to migrate or to adjust themselves to the new conditions; plants failing to do this became exterminated. All three of these processes have played a part in the development of vegetation on the earth.

The palaeontological record contains much evidence of migration, organic evolution, and extermination. The result has been an ever changing floristic scene in the geological past, leading up to the development of the present floras. This brings us to a consideration of the principle governing the evolution of vegetation.

10. *The evolution of floras is dependent upon plant migration, the evolution of species, and the selective influences of climatic change acting upon the varying tolerances of the component species.*

Migration as an agent of floristic evolution functions to bring to any region a stream of new floristic elements, that adapt themselves to the forces causing the migration with the result that a new association is developed. On the other hand, migration may carry a flora up against an impassible barrier and cause its extermination. The extermination of one species from a society of plants opens the area for the development or expansion of other species; this results in a change in the aspect of the association.

The ability of species to adapt themselves to the changed conditions is perhaps a measure of their vigor, and the more vigorous species are the more rapidly evolving. Thus, these vigorous species, by extending their tolerances and perhaps also undergoing morphological change, are introducing new plant elements into a floristic association.

The selective influence of climatic change causes some species to migrate, others to become extinct, and may well be an activating influence in the evolution of species. That such processes have been working in the past may be demonstrated by what appears to have been the nature of the origin of differentiation of certain elements of the Sierran flora of California from the Tertiary redwood flora.

A large number of Sierran species are endemic to the California flora. This is particularly true of the flora of the middle altitudes where *Pinus Lambertiana* and *Libocedrus decurrens* occur. Associated with these species are a great many plants which also occur with the redwood forest. This is especially true in the northern Sierras where the flora bears a striking resemblance in its species content and general aspect to the flora of the Coast Ranges. There is, however, no redwood.

The Sierran flora as we know it does not occur in the fossil record. In every case, species belonging to it are found in close association with the redwood. In the Santa Clara lake beds of the Pliocene (2), for example, the pine and *Libocedrus* are in association with *Sequoia* and *Pseudotsuga*. In the older Tertiary beds to the north there are five-needled fascicles similar to those of *Pinus Lambertiana* although otherwise there exists no proof of the close relationship of this pine to the modern species.

Libocedrus is of frequent occurrence in the Miocene and Oligocene. These Sierran types increase in abundance in the redwood flora up through the Pliocene, then they segregate out following lines based on relative humidity. Those tolerating arid conditions develop along the Sierra Nevada range and the removal of the formerly dominant species from the flora allows the other species to expand and take over the dominance of the forest. In the South Coast Ranges the arid phase found opportunity for some development, but is losing ground and in certain areas such as the Santa Cruz Mountains, where it formerly occurred, it is almost extinct. The sugar pine and incense cedar no longer occur there although they were present in the Pliocene.

Along with this selection it seems probable that some evolution took place. This must have involved particularly the tolerance of some of the species. There seems no other logical way of explaining the former association of species whose descendants are now living in areas controlled by different temperature and moisture ranges. How else can we explain the association of *Sequoia, Taxodium,* and *Ginkgo* in the Miocene?

Should our deductions relative to the origin of the so-called "Californian" element of the Sierran forests prove correct, we can explain the redwood element in the northern portion of it as a relict flora located near the original point of divergence in a region where the Sierra Nevada and Coast Ranges merge in the North. If the Sierran forest had a separate existence in

the Tertiary it seems that some evidence for that fact would be found in the abundant Tertiary deposits of Western North America. However, its records are always in association with the redwood flora. The diminishing abundance, in progressively older Tertiary beds, of forms closely related to modern species, is very instructive and points to the rise of a group of species destined through the agency of climatic selection and segregation to develop a new flora.

Further evidence of climatic segregation was pointed out by the writer (7) in outlining the history of the Monterey flora wherein the splitting up of a uniform Pleistocene flora into two descendants with differing climatic requirements was pointed out. Such selective influence, no doubt, plays a part in the history of the development of related discontinuous floras the world over.

Discussion. We can, therefore, expect to find in any particular region evidence that the flora had a polyphyletic source. In California, we have a large number of plants whose history is associated with the immigration from the north of the redwood, and out of this migrating flora several of the major plant associations of Western America were segregated. There is a large element in the California flora that has adapted itself to the changes attendant upon the southward movement of the redwood. This element was the flora of the Tertiary Archipelago of California, which had a maritime phase restricted to the windward side of the islands and an arid phase occupying the leeward side of the islands much like the modern flora of Cedrus Island. This arid phase extended southeastward on the continent toward the plateau region of Mexico. The non-adaptive elements of this flora were segregated far to the southward and survive in the plateau regions of Mexico. From this southern region in Post-Pleistocene time, attendant upon the amelioration of climatic conditions, there is evidence of another migration proceeding northward and some conspicuous elements of our flora can be traced to these areas. The details of these migrations are in the process of being assembled and before long we shall have enough material for a reasonably complete account of their history.

University of California,
November, 1935.

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LIGNIFICATION OF XYLEM FIBRES IN PARKINSONIA ACULEATA

Flora Murray Scott

Parkinsonia aculeata,[1] one of the palo verdes of the southwestern desert, is commonly cultivated in Los Angeles County, and in the Palm Springs region. It is a handsome tree, freely branching, with a wealth of yellow flowers in early summer (5). The formation of cork is confined almost entirely to the main trunk, which, in consequence, alone lacks the gay green color to which the palo verde owes its name.

Microscopic examination of the switch-like stem reveals such obvious xerophytic characters as the heavy cutinization of the persistent epidermis, the sunken stomata, the presence of a hypodermal layer of water-containing cells, and the development of a photosynthetic cortex. A striking feature of the stem is the abundance of starch throughout the completely lignified xylem.

The present paper is concerned with the development of the starch-containing fibres which make up the bulk of the xylem tissue.

Observations

In the xylem of *Parkinsonia,* seasonal rings are well marked, and the wood is made up of the following elements: tracheal tubes, fibres, and medullary rays. No unlignified, thin-walled xylem parenchyma was noted in the differentiated stems. The fibres are of the type termed "substitute fibres" by Eames and MacDaniels (4), i.e., living fibre elements which function in food storage. In *Parkinsonia* occur two types of substitute fibres which

[1] Correction: in a previous paper by the author, "The anatomy of *Cercidium Torreyanum* and *Parkinsonia microphylla*" (Madroño 3: 33–41. 1935), for *Parkinsonia microphylla* read *Parkinsonia aculeata* in the title and throughout the article.

differ in time of formation, and in thickness of wall. Those which are formed at the beginning of the season's growth, at the same time as the tracheal tubes, are relatively thin-walled and correspond to the spring wood of a typical tree. They will be described as spring substitute fibres. Those laid down in the latter part of the growth period, on the other hand, are very thick-walled, and since they are equivalent to normal summer wood will be given the somewhat awkward term of summer substitute fibres. Tracheal tubes are absent from the later wood.

In regard to the differentiation of the fibres, it is of course impossible to follow the development of individual elements. By examining numerous sections, however, a series of substitute fibres in varying stages of growth may be found, and from these a connected picture of the growth of the two types may be built up. The activity of the cambium naturally varies in the course of the season. In the non-growing period the cambium lies adjacent to the completely differentiated xylem, while during active growth a number of differentiating elements intervene between cambium and xylem and form therefore the most useful material for examination.

In observing the development of the cell wall, several microchemical tests are provisionally accepted for the identification of pectic substances, of cellulose, and of lignin. These are as follows: for pectic substances, ruthenium red; for cellulose, chlor-zinc-iodine, sulfuric acid, iodine and sulfuric acid; for lignin, phloroglucin and hydrochloric acid (2, 10).

A spring substitute fibre arises from the division of a cambial cell, and the first step in the process of differentiation is the enlargement of the cell lumen. This implies a stretching of the cell wall, but since deposition of cell wall material at this time more than keeps pace with the stretching, the cell wall actually gains in thickness. A primary wall, usually called the middle lamella, and a secondary layer are already present, the former consisting mainly of pectic substances, and the latter of pectic substances and cellulose.

Cambial activity continues meantime, and, as one daughter cell after another is cut off, a zone of differentiating xylem tissue results. At a certain point in growth a chemical change occurs in the wall of the differentiating substitute fibre. The first traces of lignification appear either intermittently or continuously along the middle lamella, and thereafter lignification spreads throughout the secondary layer. That this change in the chemical nature of the cell wall does not entail any microscopically measurable increase in cell wall thickness may be seen in figure 1 (pl. X). Here is illustrated a zone of differentiating xylem tissue, in which the cells to the left of *A–B* are unlignified, while in those to the right of *A–B* lignification has taken place. Microscopically it is impossible to measure any difference in thickness

between unlignified cell wall *6* and the adjacent lignified cell wall *7*.

The differentiating spring fibre with its lignified wall is still a living cell with nucleus, chondriosomes, and small starch grains. The protoplast continues for a time to add to the thickness of the lignified wall, but finally ceases with the formation of a tertiary lamella. This appears first of all as a very thin layer of cellulose and pectic substance, in sharp contrast therefore to the lignified secondary layer. Like the secondary layer, however, it very soon becomes more or less heavily lignified. Such is the history of the development of a spring substitute fibre. The progressive increase in wall thickness is illustrated in figure 2 (pl. X), where the walls range from 1.1 microns in the cambium to 2.5 in the starch-containing differentiated substitute fibre.

In regard to the differentiation of a summer substitute fibre, the early stages of growth are similar to those of the spring fibre just described. Primary, secondary and tertiary layers appear in like succession, but at this point a change in metabolism occurs in the case of the summer fibre. The tertiary layer of the latter increases enormously in thickness, often exceeding the sum total of the previous layers. Pectic substances, cellulose and lignin are present as before in varying degrees. As the growth season draws to a close a final layer is deposited on the rapidly narrowing cell lumen. Treatment with sulphuric acid indicates that this layer is actually composed of two lamellae radially striated, as seen in figure 4 (pl. X). The wall when complete varies from 2.5 to 4.5 microns in thickness. When the wall of a summer substitute fibre is treated with certain microchemical reagents reactions of the various layers take place. These are summarized in Table I.

Layers iv and v: after the disappearance of layers ii and iii in concentrated sulphuric acid, the innermost lining of the fibre remains in the center of the cell lumen, and in it two distinct lamellae are distinguishable both with well marked radial striations (pl. X, fig. 4).

In the wall of such a fibre there are therefore five layers distinguishable by microchemical tests, in which the distribution of the components lignin, cellulose, and pectic substances may be diagrammatically represented (pl. X, fig. 5). It is seen that while lignin is present in all layers, cellulose is indicated only in layers ii to v, and pectic substances are distinguishable only in layers iii to v. In connection with the absence of pectin from layers i and ii, it has already been remarked that in the unlignified walls pectic substances are present in these layers. When lignification occurs it would therefore appear that all the pectic substances present in layers i and ii are converted *in situ* into lignin.

Table I

	Phloroglucin and HCl	Chlor-Zinc-Iodine	IKI and H_2SO_4	Ruthenium Red	H_2SO_4
Layer i (middle lamella)	red	orange	brown	colorless	becomes brown, does not swell, remains as network
Layer ii	pink	yellow	pale blue	colorless	becomes bluish, swells, turns buff, and dissolves
Layer iii	bright magenta	mauve	deep blue	deep red purple	becomes blue, swells strongly, dissolves
Layer iv	pale pink, thin, difficult to distinguish from iii	yellow, similar to ii, not quite so wide as iii	pale blue	light red difficult to distinguish from iii	(See text for explanation.)
Layer v	not distinguishable except with H_2SO_4				(See text for explanation.)

A notable feature in the stem and root of the palo verde is the abundance of starch present in the substitute fibres. Starch grains, as already noted, are present in the differentiating substitute fibres. They increase gradually in size until they may finally block the entire cell lumen except for small intervening spaces in which nuclei and protoplasm may be detected (pl. X, fig. 6). At the beginning of the growing season it was observed in certain cases that part of the starch reserves was being utilized, for the starch grains of the last year's xylem were considerably smaller than in the resting season.

Discussion

The chemical structure of the substance lignin is still a vexed question among the chemists (7), and microchemical methods, as at present developed, can shed little if any light on this particular problem. From a microscopic study of the development of xylem fibres, certain facts emerge which may elucidate the process of lignification from the biological standpoint.

It is generally agreed that the cell wall, as it is first formed in a dividing cambial cell, consists mainly of pectic substances.

It is observed that in the differentiating tissues sugars are abundant. Accepting provisionally the tentative formula of Dore (3) for pectin, and also its colloidal nature, we may visualize a series of pectin molecules being laid down by the active protoplast. These complex molecules, hexa-rings of galactose, arabinose, and galacturonic acid, are haphazard in arrangement and are held together by van der Waal's forces. They form an extremely plastic partition of optically isotropic material. Activity of the protoplast presumably varies at different points on the cell surface, and since deposition will occur now at one point, now at another, a series of pectic flakes will result. When deposition temporarily ceases, proteins, carbohydrates, fats and lipoid materials, present in or near the surface layer will come in contact with the pectic flake, and will temporarily adhere. Meantime deposition is active in the surrounding areas, and the adjacent pectic flakes may overlap the non-pectic materials, thus enclosing them. The result is an incompletely coordinated meshwork of pectin materials, with various other carbohydrates and proteins in the interstices.

A change is now initiated, accompanying the osmotic swelling of the cell, and the consequent stretching of the cell wall. Cellulose condensation begins to take place, and the cellulose, like the pectin, may be considered to be deposited in flakes, but in this case the flakes are made up of regularly oriented longitudinal chains as described by Sponsler (9). These flakes behave as optically anisotropic substances, and may be regarded as forming the stabilizing scaffolding in the plastic wall. At this stage of development there is a constant alternation on the part of the protoplast between pectin and cellulose formation.

Since the mesh-work of the growing wall is, as we have seen, sufficiently loose to include various organic compounds, it is not unreasonable to suppose that a specific enzyme, which we may provisionally term lignase, is present within the complex.

Meantime the activity of the cambium continues, and the first formed differentiating xylem element is removed from the main source of carbohydrate supply in the phloem by a succession of intervening cells. Across the differentiating xylem elements there thus arises a decreasing osmotic gradient.

During this period of intensive growth the transpiration current in the xylem reaches its maximum tension, and the transpiration pull will tend to withdraw water from the surrounding walls. The cell walls of the differentiating elements next to the xylem will therefore be subjected to a struggle for water, due to an osmotic pull outward and to the transpiration pull on the inner side.

It is an observed fact (6, 8), demonstrated readily by thionin and other indicators, that across the phloem, cambium and xylem there runs another gradient, that of hydrogen ion concentration. It is also known that the majority of enzymes function only

within a very narrow range of pH values. It would appear, therefore, that the functioning of the postulated enzyme lignase may be conditioned first of all by the pH value, and secondly by the water content of the cell wall, since a relative deficit of water might allow of the closer interaction of the effective substances. The process of lignification may then be regarded as a condensation reaction *in situ* taking place among the imprisoned carbohydrates, mainly pectic in nature, within the cellulose framework, and activated by a problematical enzyme lignase. The water molecules set free during the condensation process are absorbed by the protoplast itself, or are withdrawn in either the transpiration or the osmotic streams already mentioned.

If we turn to other areas in the plant where lignification is in process intermittently, for example in the zone of phloem fibre differentiation, we can see that the conditions which obtain there may be interpreted in a similar way. The phloem, due to the presence of food materials, is a region of high osmotic pressure, and next to it lies the photosynthetic cortex. The latter, during its active phases, will tend to withdraw water from every available surrounding source, and to this extent will resemble the transpiration stream of the former case in its effect. The cells on the margin of the phloem, like the cells of the differentiating region of the xylem, thus lie in a position difficult as regards water supply. Further, in the tissues at this point, there is again apparent a gradient of hydrogen-ion concentration, though in the inverse direction. Presumably the conditions in relation to enzyme activity are here similar, at least during the intermittent formation of lignified phloem fibres, to those in the zone of differentiating xylem.

That an enzyme is present during the process of lignification appears to be a reasonable proposition and should allow of direct experimental verification. Enzymes, generally speaking, catalyze either the building up or the breaking down of a particular substance. Now Alexandrov (1) in his work on hemp has shown that delignification of the xylem tissue may be consistently induced by the twisting, without breaking, of the branches of actively growing hemp. From material such as this it should be possible to isolate the enzyme concerned, if this be present.

Conclusions

1. The main bulk of the wood of the palo verde consists of substitute fibres, the walls of which vary in thickness.

2. By ordinary microchemical tests three gross layers may be distinguished in the relatively unthickened walls of the spring substitute fibres, while five are present in the very thick-walled summer fibres. These layers differ in optical and in staining properties, according to their pectic, cellulose, and lignin content.

3. The developing cell wall may be regarded as a very loose mesh-work of pectic and cellulose materials, the cellulose flakes acting as a structural scaffolding. Other non-carbohydrate substances may be enclosed within the mesh during formation.

4. Lignification, the condensation of pectic or similar carbohydrate substances, takes place *in situ* in the cell wall at a certain stage of development. The controlling factors suggested are the hydrogen ion concentration and the water content of the differentiating wall. The latter depends on the balance between transpiration pull in the xylem and osmotic forces in the differentiating phloem tissues.

5. An enzyme lignase is postulated to activate the reaction. Experimental proof of the presence of such an enzyme might be obtainable from the examination of tissues in which delignification is in progress.

6. The conditions for the lignification of the phloem fibres are seen to be essentially similar to those of the xylem elements.

7. Starch grains are present in the differentiating elements and completely block the lumen of the still living fibres at the end of the season.

University of California at Los Angeles,
August, 1935.

Explanation of the Figures. Plate X

Fig. 1. Actively growing stem: cambium *C;* unlignified differentiating xylem, *1* to *6;* partly lignified xylem elements, *7* to *10*. *A–B* is the zone of division between lignified and unlignified areas. (The uniformity in thickness of all the cell walls is seen.) (Camera lucida × 500.)

Fig. 2. Transverse section showing wall thickness in cambium *C*, and in unlignified (*1, 2*) and lignified (*3, 4, 5, 6*) differentiating spring substitute fibres. Growth less active than that illustrated in figure 1. Wall thickness in microns: 1.1, 1.1, 1.6, 1.6, 1.8, 2.5, 2.5. Starch grains *S*. Cell wall layers, *i*, *ii*, and *iii*. (Camera lucida × 500.)

Fig. 3. Transverse section showing cambium *C* and xylem (shaded) at the end of the growing season. In the walls of summer substitute fibres, five layers are indicated: *i, ii, iii, iv, v*. Thickness of the walls 2.5 to 4.5 microns. (Camera lucida × 500.)

Fig. 4. Transverse section of thickened fibre after treatment with sulphuric acid. Middle lamella, *m.l.*, layers *iv* and *v*. Diagrammatic.

Fig. 5. Longitudinal section of thickened fibre wall, showing the distribution of lignin, *L;* cellulose *c;* and pectic substances *v*. Diagrammatic

Fig. 6. Xylem fibre: starch grains *S*: protoplasm, *ppm;* nuclei, *n;* pits, *p*. Length from 240 to 480 microns. Diagrammatic.

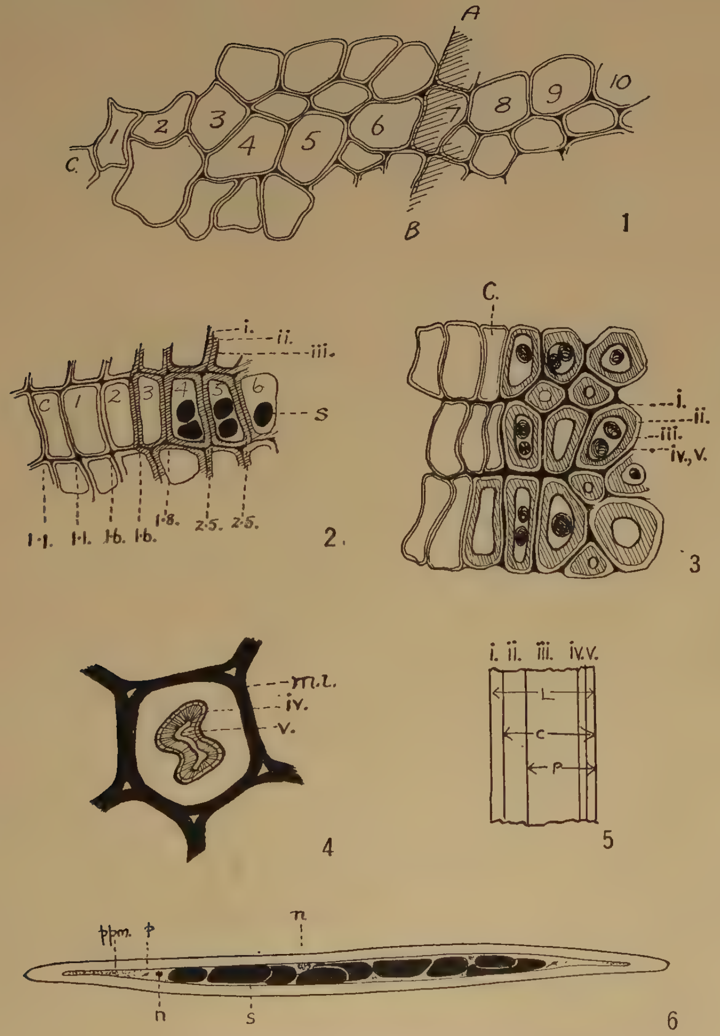

Plate X. Parkinsonia aculeata: lignification of xylem

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OUR VANISHING LICHEN FLORA

Albert W. C. T. Herre

Lichens are perhaps the least studied of any considerable group of plants. For convenience they may still be regarded as a group, although they are really a heterogenous assemblage that should be distributed among the fungi. Most writers of general texts on botany dismiss lichens with a few casual remarks replete with misinformation and inaccuracies. It has been said that lichens are the most difficult group of plants, but this is a gross overstatement. One has but to contemplate some of the fungi, Leguminosae (*sensu lato*), Compositae, Orchidaceae, or other large assemblages, to recognize that there are plenty of puzzles among plants other than lichens.

Yet despite the real or apparent difficulties of lichen study, and the vast distance of California, in early days, from centers of study or research, the lichen flora of the state long ago attracted the attention of European and New England botanists. No other part of our country has such a large number of endemic lichens notable for size, unusual thalline development, or other peculiarities which force them upon our attention. Then, too, a number of European species occur in California, although not in the regions east of the Sierra Nevada. Menzies, Bolander, and other keen observers supplied Tuckerman with specimens which the latter described. Later, Dr. H. E. Hasse and the writer made large collections of the lichens peculiar to California. When I left California in 1912 it was still possible, with one or two exceptions, to collect endemic lichens in their type localities.

What is the condition to-day? The regions where Bolander gathered amazing forms in abundance have long since been devastated by "real estaters," while it is now absolutely impossible to collect lichens in the favorite haunts of Dr. Hasse and myself, where hitherto unknown species were brought to light every year, or species new to North America were constantly being discovered.

In most regions throughout the world the press of population and the growth of factories merely "cramps the style" of lichens, and they are still able to maintain themselves in decency if not in luxury. But how is it in California? Consider conditions to-day in localities such as the Santa Monica hills, the coast of Southern California, Catalina Island, the plains, foothills, and mountains of the Santa Cruz Peninsula, the cliffs of Point Lobos, the cypresses and crags of the Seventeen Mile Drive, the Oakland Hills, Sutro Heights, Cliff House, and Twin Peaks at San Francisco. Miles of terrain are covered with asphalt, concrete and houses. Cliffs are obliterated entirely, or their faces have not only been "lifted" but removed so that they stand fifty feet or more further back than formerly. Their resident lichens have been not merely discouraged, they have been wiped out of existence. Those who remember the Cliff House in 1900 will know what I mean.

The Monterey cypresses with their extraordinary coats of luxuriant endemic lichens have been shut off from the public by converting the Seventeen Mile Drive into a real estate subdivision. The old fences, covered with a most extraordinary and luxuriant assemblage of rare lichens, whether at Alviso or the crest of the mountains, have been replaced by barbed wire. The county road back of Stanford University, with its high, shaded bank covered with rare lichens, has been replaced by a wide paved highway, and the banks where Dr. Peirce and I gathered rare plants are totally gone—used to fill some gully. I have searched in vain for many earth lichens once found along every foothill and mountain road in the Santa Cruz Peninsula. Useless was my search for the lichens endemic to the rock ledges crowning the Oakland and Berkeley hills. Where it is not all streets and houses, misguided zealots have made the countryside resemble a city playground, as far as lay within their power. It is perhaps worse in the vicinity of Santa Monica and Los Angeles where Dr. Hasse spent so many years.

I therefore urge that before it is too late, the botanists of California collect ample material of all lichens available. The coast north of San Francisco and the coast between the Monterey Peninsula and Santa Barbara should still shelter most of our rare and curious maritime lichens. Here and there one may see a few staggering panels of some crazy fence of redwood paling erected fifty to seventy-five years ago, while along the coastal

roads old board fences are occasionally seen. Every such bit of fence should be scrutinized and its lichens collected. Apparently our state is gradually becoming dryer; deforestation, the greater demand for water, and the capture of water that once fed springs and brooks, all combine to help make life more difficult for earth lichens. As the rainy season approaches, the collection of lichens becomes easier. Every botanist should make an effort during the coming winter to collect typical examples of all the lichens he sees. If this is not done soon, many of our lichens of greatest interest will exist only in one or two European and in two or three American herbaria.

I have not said anything of the fundamental importance of lichens as soil makers, nor of their being just as valuable as any other plants in the study of ecology. One could give many sound reasons for their collection and study, but at this time I merely urge that all botanists do what they can to get first-class specimens illustrative of some of our most unique plants, for the benefit of posterity.

Stanford University,
September, 1935.

STUDIES IN PENSTEMON—II. THE SECTION HESPEROTHAMNUS

David D. Keck

The first revisional work in *Penstemon* by the present writer was published in 1932.[1] Many notes and a little manuscript were compiled thereafter in the expectation that these monographic studies in the genus would continue. Unforeseen developments caused my attention to be turned to other taxonomic problems but the opportunity has been sought to resume work in this genus when time permitted. The opportunity came in the winter of 1935 to study material of *Penstemon* in several important herbaria.

This, the second paper of the *Penstemon* series,[2] treats the shrubby Pacific Coast species of the section *Hesperothamnus*, which is proposed here as new. The results are largely the outcome of herbarium studies, although six of the eight species treated have been studied in the field and five of them have been grown for several years in the gardens of the Carnegie Institution of Washington at Stanford University.

All the material in the following herbaria has been examined:

A—Arnold Arboretum, Harvard University, Jamaica Plain, Mass.

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[1] Studies in Penstemon. A systematic treatment of the section Saccanthera, Univ. Calif. Publ. Bot. 16: 367–426. 1932.

[2] A part of the cost of publication of this article is borne by the Carnegie Institution of Washington.—Ed.

C—University of California, Berkeley.
CI—Carnegie Institution of Washington, Stanford University, California.
CAS—California Academy of Sciences, San Francisco.
F—Field Museum, Chicago.
GH—Gray Herbarium, Harvard University.
M—Missouri Botanical Garden, St. Louis.
ND—University of Notre Dame, Notre Dame, Indiana.
NY—New York Botanical Garden.
Ph—Academy of Natural Sciences, Philadelphia.
Po—Pomona College, Claremont, California.
RM—Rocky Mountain Herbarium, University of Wyoming, Laramie.
SU—Dudley Herbarium, Stanford University, California.
US—United States National Herbarium, Washington, D. C.

The helpful cooperation of the curators of these institutions and the aid I have received from others, particularly my colleague Dr. Jens Clausen, during the course of this study is gratefully acknowledged. Space prevents the giving of more than representative citation, but the distributional maps plot many other stations from which material has been seen.

Affinities of the Section Hesperothamnus

The group of species treated here has never before been given sectional ranking, yet is one of the most natural and distinct entities in this large genus. The eight species composing this section show much evidence of close interrelationship, but they are so clearly marked off from other species of *Penstemon* that it is difficult to suggest their nearest affinities outside the section. A certain floral similarity exists between *P. ternatus* of section *Hesperothamnus* and *P. labrosus* as well as other species of the section *Elmigera*. However, a closer morphological similarity in floral features probably exists between several species of section *Hesperothamnus* and the *P. Palmeri* group of section *Spectabiles*. Characters of pubescence of the corolla-throat and the filaments, the anthers and the staminode, and corolla-shape are the principal ones that are suggestive in this connection. Although a bridge may exist between sections *Hesperothamnus* and *Spectabiles*, the scarlet-flowered species of section *Hesperothamnus* must have had a development independent of any other section with scarlet-flowered species. Which section is the older is not clear at present. The mere fact that in one the species are woody while in the other they are herbaceous does not settle the matter.

Species of section *Hesperothamnus* tend to have parallel variations particularly as regards pubescence. All the species, compared to others of the genus, are of rather wide distribution, the limits, presumably, being those set by climatic factors. Proba-

bly these species have been coexistent for a very long period and perhaps from their earliest differentiation have had many genes in common which played a part in moulding their subsequent variants.

HESPEROTHAMNUS Keck sect. nov.

Fruticosi, as subsection, A. Gray, Syn. Fl. 2[1]: 260. 1878.

Erect shrubs; stems very woody at least below, usually producing short branchlets almost throughout; leaves coriaceous; sepals entirely herbaceous or with narrow hyaline margins; *corolla strongly bilabiate,* glandular-pubescent externally, pubescent within at base of throat, the *upper lip subgaleate,* terminating with two very short lobes, the lower lip parted more than half way to base with three *strongly recurved* lobes; stamens exceeding throat, the anthers protected under upper lip, the filaments flattened, dilated usually and *strongly pubescent at base,* the anther-sacs widely divaricate, explanate (except in *P. Rothrockii*), ovate to rotund, glabrous; capsule brown, ovoid; seeds very irregular, the seed-coat usually compressed into narrow wings. Largely chaparral species of Western North America. Type species, *Penstemon cordifolius* Benth.

Key to the Species and Subspecies

Corolla fulvous, yellowish or whitish, not distinctly tubular, with prominent guide lines extending from lower lip into throat. Largely pollinated by bees.	
Inflorescence spicate-racemose; pedicels shorter than calyces; flowers solitary or geminate	1. *P. Rothrockii*
Corolla 10–12 mm. long, glabrate; leaves gray with a short scabrous pubescence	1a. subsp. *typicus*
Corolla 13–15 mm. long, sparsely villous outside; leaves green, glabrate	1b. subsp. *jacintensis*
Inflorescence paniculate or thyrsoid; pedicels longer than calyces; flowers usually geminate or several.	
Sterile filament glabrous; corolla white tinged with pink, long-hirsute without	2. *P. breviflorus*
Calyx glandular-pubescent	2a. subsp. *typicus*
Calyx glabrous	2b. subsp. *glabrisepalus*
Sterile filament densely bearded; corolla short-pubescent without.	
Stem glaucous; leaves elliptic, 1–4 cm. long, 5–18 mm. broad, denticulate; corolla *ca.* 4 mm. broad, fulvous with yellowish lower lip	3. *P. Lemmonii*
Stem not glaucous; leaves linear-oblanceolate, 0.5–2 cm. long, 2–8 mm. broad, usually entire, corolla *ca.* 10 mm. broad, yellow.	
Twigs glabrate or puberulent, herbage green; sepals ovate, obtuse. Coastal	4. *P. antirrhinoides*
Twigs cinereous, herbage pallid; sepals ± long-acuminate. Desert	5. *P. microphyllus*
Corolla red, distinctly tubular. Largely pollinated by humming-birds.	

Leaves opposite, narrowly elliptic to narrowly cordate; stems not glaucous.
Sterile filament bearded at tip; leaves mostly subcordate at base; inflorescence a deltoid thyrse of reflexed branches; corolla-limb 15 mm. long; scandent. Southern California .... 6. *P. cordifolius*
Sterile filament bearded to base; leaves acute or obtuse at base; inflorescence a few- to many-flowered corymbiform cyme of ascending branches; corolla-limb 12 mm. long; not scandent. Northern California.
Herbage glabrous .... 7. *P. corymbosus*
Herbage puberulent to cinereous .... 7a. var. *puberulentus*
Leaves ternate, narrowly elliptic to narrowly cordate; inflorescence an elongated racemose thyrse; stems glaucous .... 8. *P. ternatus*
Calyces and pedicels glabrous .... 8a. subsp. *typicus*
Calyces and pedicels glandular-pubescent .... 8b. subsp. *septentrionalis*

1. Penstemon Rothrockii A. Gray

Penstemon Rothrockii A. Gray, Syn. Fl. 2[1]: 260. 1878.

Shrub 3–6 dm. high; herbage grayish to light green, finely puberulent to hispidulous throughout, often slightly glandular within the inflorescence: leaves 5–15 mm. long, 2–7 mm. wide, subsessile, lance-oblong to ovate, entire or remotely undulate-denticulate: inflorescence a strict spiciform raceme, 3–15 or 20 cm. long; flowers usually geminate but frequently alternate toward apex of the inflorescence, subsessile: calyx 4–6 mm. long, glandular-hispidulous; sepals lanceolate to ovate-lanceolate, acuminate: corolla brownish yellow with red-brown or purplish guide lines, 11–16 mm. long, 3–5 mm. broad at summit of throat, subcylindric; upper lip erect, occasionally moderately ampliate, 4–5 mm. long, faintly keeled: sterile filament glabrous at tip, included: anther-sacs dehiscent throughout but not explanate, oblong, 0.8–1.1 mm. long.

Southwestern Nevada and southeastern California.

1a. Penstemon Rothrockii subsp. typicus nom. nov.

Penstemon Shockleyi S. Wats. Proc. Am. Acad. 23: 265. 1888. Type locality: "On Miller Mountain, Esmeralda County, Nevada, at 8,000 feet altitude (*W. H. Shockley, 1886*)." Watson mistook this for a member of the *P. deustus* group and failed to point out its connection with *P. Rothrockii,* which he apparently overlooked. The type of this is a good match for the type of *P. Rothrockii,* differing only in having slightly more glabrate leaves.

Penstemon scabridus Eastw. Bull. Torr. Club 32: 208. 1905. Type locality: " . . . near Kern Lakes and on the Hindman's Trail over Coyote Pass, Tulare County, California, July 19, 1903" (Eastwood). This locality is not distant from the type locality

of *P. Rothrockii,* which species this matches in all respects and which Miss Eastwood overlooked.

From the upper Transition Life Zone to timber-line (2,100 to 3,200 meters), Mono County to Tulare County, California, and adjacent southwestern Nevada. Type locality: "S. E. California, on Little Olanche Mountain, toward the sources of Kern River, at 10,400 feet, *Rothrock.*" This is *Rothrock 341* (see Rothrock, Rep. U. S. Geogr. Surv. 6: 370. 1878) and not at all *Rothrock 332* from the same locality and which Gray had before him when writing his description. The latter is *P. Newberryi* Gray and because of the fragmentary nature of the specimen was mistaken by him for the present species.

Nevada. Esmeralda County: Miller Mt., *Shockley 539* (GH, type of *P. Shockleyi;* isotypes F, NY, SU, US); Silver Peak Mts., *Goldman 2581* (US). Clark County: Lee Canyon, Charleston Mts., *Heller 10994* (A, C, F, GH, M, NY, Ph, SU, US); MacFarlands Spring, Charleston Mts., June 28, 1928, *Jaeger* (CI, GH, SU). California. Mono County: above Long Valley on Benton road, *Ferris 6774* (SU); Marble Canyon, White Mts., Aug. 3, 1930, *Duran* (C, CAS, F, M, NY, RM, US). Inyo County: Westgaard Pass, July, 1928, *Jones* (Po); Surprise Canyon (Panamint Mine), Panamint Mts., *Hall & Chandler 7005* (C); Cottonwood Creek, *Purpus 1914* (C); between Bishop and Anderson's Camp, 1913, *Brandegee* (C). Tulare County: Kern Canyon opposite Junction Meadow, *Bacigalupi 1744* (SU); Little Kern River, *Purpus 5158* (C, GH, M, US); Soda Springs, Upper Kern River, *Hall & Babcock 5414* (C, SU); near Kern Lakes, July 19, 1903, *Eastwood* (CAS, type of *P. scabridus*); Little Olanche Mt., *Rothrock 341* (GH, type; isotypes F, US); Lloyd Mountain Sequoia Grove, *Dudley 851* (SU).

1b. Penstemon Rothrockii subsp. jacintensis (Abrams) comb. nov.

Penstemon jacintensis Abrams, Bull. Torr. Club 33: 445. 1906.

Penstemon Rothrockii var. *jacintensis* (Abrams) Munz et Johnst. Bull. So. Calif. Acad. Sci. 23: 27. 1924.

San Jacinto Mountains, Riverside County, California, at elevations of 2300 to 2800 meters. Type locality: "San Jacinto Mountain, altitude 9,000 feet, *H. M. Hall 704.*"

California. Riverside County, San Jacinto Mts.: *Parish 473* (C, F, GH, M, SU, US); Tamarack Valley, *Hall 704* (US, type); Round Valley, *Munz 6400* (GH); Tahquitz Peak, Sept. 6, 1929, *Hoffmann* (CAS); Tahquitz Valley, *Hall 2588* (C, M, NY, SU, US).

Penstemon Rothrockii has two natural geographic subspecies. In a species whose distribution is marked by broad gaps due to its occurrence on isolated mountain ranges, a single instance of

isolation may scarcely be selected as a basis for a subspecies with but a trifling morphological character for substantiation. The unit *jacintensis* must stand on the basis of the 1 to 3 mm. increase in corolla-length of San Jacinto Mountains material. Other criteria that have been proposed for the support of this as a separate species and as a variety, such as differences in flower color and sepal shape, appear to have no foundation. Corollas of subsp. *jacintensis* are 13 to 16 mm. long and are often ampliate at the throat so as gradually to arcuate the upper side and increase the width to 5 mm. Subspecies *typica* has straight corollas 11 to 13 mm. long, which are not noticeably ampliate nor much over 4 mm. in breadth. However, *Baker 4400a* (CI), from Coyote Pass, Tulare County, near the type locality of *P. Rothrockii,* has corollas up to 14 mm. long. The leaves of this specimen are green, a character attributed solely to their variety *jacintensis* by Munz and Johnston. While the corolla is always glandular-pubescent externally (contrary to Gray's description) in both subspecies, material from southern Sierra Nevada differs from all the rest in the less strongly hirsute pubescence on the limb. Leaves are glabrate, being puberulent only toward the base of the blade, except that in most of the Sierran material the leaves are definitely hispidulous.

From this it is apparent that subsp. *jacintensis* may stand on its corolla-size character, admitting some overlapping, but the erratic distribution of minor variations in the amount of pubescence uncorrelated with other characters prevents the confirmation of further subspecies and likewise prevents the re-erection to specific rank of *P. jacintensis.*

2. Penstemon breviflorus Lindl.

Penstemon breviflorus Lindl. Bot. Reg. 23: t. 1946. 1837.

Shrub 5–20 dm. high, the stem and often the leaves glaucous, glabrous up to the ultimate pedicels of the inflorescence: leaves 10–50 or 70 mm. long, 3–12 mm. wide, subsessile, linear-lanceolate to broadly lanceolate or oblanceolate, serrulate to entire: inflorescence a thyrsus of many cymules, 5–30 cm. long; peduncles divergent, 0.5–6 cm. long: calyx 5–8 or 10 mm. long, glabrous or glandular-pubescent; sepals broadly lanceolate to ovate, acuminate: corolla white flushed with rose on lobes and within upper lip; with claret guide lines and a band of claret at base of throat, reddish yellow in bud, 15–18 mm. long and more or less strongly hirsute on limb externally; tube shorter than calyx; throat short, moderately expanding; upper lip arched, *ca.* 10 mm. long, strongly keeled: sterile filament glabrous at tip, slightly exserted: anther-sacs less than 1 mm. long.

Sierra Nevada in westernmost Nevada and in California throughout the Sierra Nevada and Coast Range.

2a. Penstemon breviflorus subsp. typicus nom. nov.

Penstemon carinatus Kellogg, Proc. Calif. Acad. 1: 63. 1855. The type has been lost.

Penstemon canoso-barbatus Kellogg, Proc. Calif. Acad. 2: 15. 1860. Type from Yosemite. The description clearly applies to this species, but as no mention was made of the pubescence of the calyx, and as the type specimen has been lost, it is impossible to assign it to the correct subspecies. The figure in Hutchings Magazine (vol. 5, p. 103, 1860) has not been seen.

Penstemon breviflorus canoso-barbatus (Kell.) Schelle, Handb. Laubh. Benen. 432. 1903.

Penstemon breviflorus carinatus (Kell.) Schelle, l. c.

Southern Washoe County, Nevada; Sierra Nevada, California, from Nevada County to Los Angeles and Ventura counties, thence northerly through the Coast Range to Mount Hamilton. Occasional in dry rocky places of the lower Transition and bordering Upper Sonoran Zone from 450 to 1830 meters altitude. Type locality: California. Lindley described and figured this from a plant raised in the garden of the Horticultural Society from seeds picked off some of Douglas' dried specimens. Douglas' plants probably came from Monterey County (Santa Lucia Mts.). Lindley's figure is accurate and may be taken as the type in lieu of a wild plant from Douglas' collections.

Nevada. Washoe County: Broncho Creek, *Kennedy 938* (RM). California. Nevada County: Emigrant Gap, *Jones 3276* (CAS, M, Ph, US). Placer County: Forest Hill, *Smith 1830* (CAS); 2.3 mi. S. E. of Loomis, *Keck 2432* (CI, Po, SU). Amador County: French Garden, *Hansen 443* (A, C, M, SU, US). Inyo County: Cottonwood Creek Canyon, *Purpus 1907* (C). Tulare County: Old Colony Mill, July 26, 1905, *Brandegee* (C, NY, US); Marble Fork Bridge, Sequoia Nat'l Park, *Abrams 7749* (A, NY, SU); Middle Tule River, *Purpus 5575* (C, GH, M, US). Kern County: Greenhorn Mts., *Palmer 71* (M, NY, US); Walker Basin, *Coville & Funston 1095* (US); Bisses Station, Tehachapi Mts., *Dudley 508* (C, NY, SU, US); Fort Tejon, *Xantus 62* (NY, Ph, GH, US). Los Angeles County: between Oakgrove Canyon and Elizabeth Lake, *Abrams & McGregor 409* (A, GH, NY, Po, SU, US). Ventura County: Mutau Flat, *Dudley & Lamb 4765* (DS); Seymour Creek, Mount Pinos, *Peirson 3237* (Po, RM, SU). Santa Barbara County: Zaca Mt., June 17–22, 1902, *Eastwood* (GH, NY). San Luis Obispo County: Paso Robles Springs, *Palmer 328* (C, M, NY). Monterey County: Tassajara Hot Springs, *Elmer 3358* (M, SU, US); between King City and Jolon, June 18, 1908, *Brandegee* (C); San Carpajo Canyon, June 1912, *Condit* (C). San Benito County: Hernandez, June 28, 1903, *Lathrop* (SU). Santa Clara County: Mount Hamilton, *Smith 20* (C).

2b. Penstemon breviflorus subsp. glabrisepalus subsp. nov.

Quoque subsp. typicae aliter omnino similis differt calycibus glabris.

Occasional in Nevada from Ormsby County to Douglas County, and in California from Shasta County to Tulare County and from Mendocino County to Napa County, occurring in dry rocky places in the Upper Sonoran and Transition zones from 180 to 2070 meters elevation.

Type: *Keck & Heusi 283* (Dudley Herbarium of Stanford University, No. 187668; isotypes Berlin, C, CI, GH, Kew, Conservatoire de Botanique, Geneva, M, Ph, Po), collected at Mather, Tuolumne County, California, 1400 meters elevation, July 14, 1927.

Nevada. Ormsby County: mts. west of Carson City, *Heller 9814* (A, GH, NY, Ph, SU, US); Kings Canyon, *Baker 1257* (A, C, CAS, GH, M, NY, RM, US). Douglas County: Cave Rock, *Hall & Chandler 4595* (C). California. Shasta County: Oak Run, May 20, 1894, *Baker & Nutting* (C, RM). Tehama County: Red Bluff, June 1917, *Wickes* (CAS). Butte County: Iron Canyon, *Austin 65* (C, M, US); Table Mt., *Heller 10785* (A, C, F, GH, M, NY, Ph, SU, US). Yuba County: Bullards Bar Reservoir, *Keck 984* (C, CAS, CI, Copenhagen, GH, M, Ph, Po, SU). Nevada County: Penn Valley west of Grass Valley, *Heller 13192* (A, CAS, F, GH, M, NY, SU, US). Amador County: Ione, *Braunton 1040* (M). Calaveras County: Copperopolis, *Davy 1350* (C). Mono County: Leevining Canyon, 8500 ft., *Keck & Stockwell 3896* (C, CI, SU). Mariposa County: Yosemite Valley, *Abrams 4524* (A, C, GH, NY, SU, US). Madera County: Raymond, *Eastwood 12561* (A, CAS). Fresno County: Tehipite Valley, *Hall & Chandler 460* (C, M, NY, SU, US). Tulare County: Sequoia Nat'l Park, Aug. 1925, *McCracken* (SU). Mendocino County: Ukiah, *Eastwood 3388* (CAS, US). Lake County: Mount Konocti, June 10, 1926, *Blankinship* (CAS); Allen Springs, June 22, 1882, *Cleveland* (C). Napa County: Pope Creek, *McMinn 207* (SU).

One collection, made between Bartletts and Clear Lake, Lake County, *Abrams 6288* (NY, SU), I take to be a natural hybrid between this subspecies and *P. Lemmonii* Gray judging from aspect, short corolla, light tuft of beard on the staminode, and the lightly pubescent calyx.

The proposal of a new subspecies here recognizes the evident segregation of the species into a southwestern component with strongly glandular-pubescent sepals and a northeastern component with glabrous sepals. In the Coast Range these subspecies do not meet but in the Sierra Nevada they occur together for a considerable distance with consequent hybridizing and dilution of the distinction between them.

3. Penstemon Lemmonii Gray

Penstemon Lemmonii Gray, Bot. Calif. 1: 557. 1876.

Shrub 5–15 dm. high: herbage bright green, at least the stems glaucous, glabrous up to pedicels of inflorescence: leaves 10–45 or 60 mm. long, 5–20 or 28 mm. wide, ovate-lanceolate to elliptic, serrulate to subentire: inflorescence a narrow elongated panicle of very many cymules, 5–40 cm. long; peduncles divergent, 0.5–2 or 3 cm. long: calyx 4–7 mm. long, glandular-pubescent; sepals lanceolate, attenuate: corolla purplish brown, the lower lip pale yellow within with purple guide lines, 10–14 mm. long, inflated dorsally; tube scarcely equaling calyx; throat abruptly expanding; upper lip erect, *ca.* 5 mm. long: sterile filament densely canary-yellow-bearded for two-thirds its length, somewhat exserted: anther-sacs 0.8 mm. long.

California, in the Coast Ranges from Siskiyou County to Humboldt and Solano counties, and in the Sierra Nevada from Mount Shasta to Lake Tahoe, extending slightly into Washoe County, Nevada; at elevations of 500 to 2100 meters. Type locality: "Long Valley, Mendocino Co. (*Kellogg,* 1869), Plumas Co. (*Lemmon,* 1874)." In spite of the fact that this species was named in honor of Lemmon, I choose the former collection as the type. It was distributed as from Long Valley, Mendocino County, *Kellogg & Harford 678*. The type is at Gray (isotypes, CAS, NY, US). Lemmon's sheets at Gray Herbarium bear the meagre information: Plumas County, *Lemmon 1128,* and Sierra County, 1874, *Lemmon 154*. As neither coincides accurately with Gray's data, neither is as desirable as the Long Valley specimen for the type.

Nevada. Washoe County: Slide Mt. near Franktown, *Tidestrom 10500* (Ph); mts. west of Bowers, *Heller 10662* (A, CAS, CI, F, GH, M, NY, SU, US). California. Siskiyou County: Clark Mine, Russian Creek, *Butler 426* (C); W. flank of Mount Shasta, *Keck 1265* (C, CAS, CI, SU); Cantara, *Eastwood 1348* (CAS, GH, M, NY, US). Shasta County: Dunsmuir, *Heller 12493* (A, CAS, F, GH, M, Ph, SU, US); Pitt to Baird, *Eastwood 1446* (CAS, GH, NY, US). Trinity County: Trinity Alps, *Baker 183* (SU). Plumas County: Crescent Mills, June 29, 1920, *Clemens* (CAS, NY, Ph); 3 mi. N. of Keddie, *Keck 1712* (CAS, CI, Po, SU). Nevada County: Truckee, *Sonne 255* (F, M, Ph, SU, US); Donner Lake, *Heller 7013* (A, C, GH, M, NY, Ph, RM, SU, US); Soda Springs, *Jones 2596* (F, M, Ph, SU). Placer County: Deer Park, *Geis 163* (C, GH, M, RM, US). El Dorado County: Meek's Bay, Lake Tahoe, *Heller 13332* (A, CAS, F, GH, M, NY, Ph, SU, US). Glenn County: E. of Newville, *Heller 11519* (A, CAS, F, GH, M, NY, ND, SU, US). Yolo County: Buckeye Creek, *Stinchfield 351* (NY, SU). Humboldt County; jct. E. of Arcata, *Jones 28828* (C, M); Klamath River, mouth of Slate Creek, *Tracy 5352* (C); Trinity River near Willow Creek,

Tracy 3504 (C). Mendocino County: Talmadge, *Howell 6699* (CAS); Ukiah, Aug. 11, 1908, *Condit* (C). Lake County: Elk Mt., *Tracy 2338* (C, US); Adams Springs, *Howell 5456* (CAS, CI). Napa County: Pope Creek Canyon, *Howell 4356* (C, CAS, CI); Howell Mt., *Bacigalupi 1873* (NY, SU). Solano County: Vacaville, June 20, 1892, *Jepson* (C).

4. Penstemon antirrhinoides Benth.

Penstemon antirrhinoides Benth. in DC. Prodr. 10: 594. 1846.

Lepidostemon penstemonoides Lem. Illustr. Hortic. 9: t. 315. 1862.

Penstemon Lobbii Hort. ex Lem. l. c.

Spreading shrub 6–20 dm. high: herbage bright green, not glaucous, finely puberulent throughout, not noticeably glandular: leaves 5–23 mm. long, 2–8 mm. wide, linear to oblanceolate or rarely elliptic, usually entire; petioles corky at base and floccose in fascicles which occur on older wood: inflorescence a broad leafy panicle, much branched, 5–30 cm. long; peduncles divergent, 1–1.5 cm. long, 1–3-flowered: calyx 3–6 mm. long, microscopically glandular-puberulent; sepals ovate to rotund, obtuse or cuspidate-acute: corolla bright yellow with reddish lines without, brownish red in bud, 16–20 mm. long, *ca.* 8–10 mm. broad at throat; tube shorter than calyx; throat abruptly wide-expanding; upper lip erect to arcuate, 9–12 mm. long, boat-shaped, keeled: sterile filament densely yellow-bearded for two-thirds its length, well exserted: anther-sacs 1.6–1.9 mm. long.

Frequent on dry, chaparral-covered slopes of the Upper Sonoran Zone in the interior coastal drainage region from southwestern San Bernardino County, California, to the San Pedro Martir Mountains, Baja California, Mexico, at elevations of 200 to 1200 meters (to 2500 meters on San Pedro Martir). Type locality: California. The type collected by Coulter, in Herb. Hookerianum, Kew, not seen by me.

California. San Bernardino County: Mill Creek, *Smith 34* (C); San Bernardino Valley, *Parish 4171* (C, GH, M, NY, US); Slover Mt., *Parish 107* (A, C, F, M, NY, Ph, SU, US). Riverside County: Banning, May 28, 1928, *Van Dyke* (CAS); Idyllwild, July 10, 1928, *Van Dyke* (C, CAS); San Jacinto River, 2500 ft., *Hall 2016* (C, M, Ph, SU, US); Glen Ivy, *Craig 206* (Po, SU). Orange County: Santa Ana Canyon, *Munz et al. 2621* (Po, SU, US). San Diego County: between Fallbrook and San Luis Rey, *Abrams 3347* (A, F, GH, M, NY, Ph, SU, US); Foster, *Hall 3879* (C, F, NY, RM, US); Santa Ysabel, *Henshaw 146* (NY, US); between Campo and Potrero, *Abrams 3712* (GH, NY, SU); Dalzura, *Spencer 118* (C, GH, US). Mexico. Baja California: Tecate River, near Monument 245, *Schoenfeldt 3736* (SU, US); Ensenada to Ojos Negros, *Goldman 1110* (US); Refugio Ranch (50 mi. S. of Ensenada), *Ballou 24* (C); San Vicente, Apr. 17,

1925, *Jones* (Po, SU, US); San Pedro Martir, 8200 ft., May 19, 1893, *Brandegee* (C).

5. Penstemon microphyllus A. Gray

Penstemon microphyllus A. Gray, Pacif. Rail. Rep. 4: 119. 1857.

Penstemon Plummerae Abrams, Bull. Torr. Club 33: 445. 1906. The type, from Mineral Park, Mohave County, Arizona, June 1884, *Lemmon* (US; isotype C) has been studied and found to be this. Since Abrams makes no reference to *P. microphyllus* Gray, it is probable that he overlooked this species.

Penstemon antirrhinoides var. *microphyllus* (Gray) Munz et Johnst. Bull. Torr. Club 49: 43. 1922.

Closely similar to *P. antirrhinoides* Benth. differing in the following characters: herbage yellowish gray-green, canescent throughout, the twigs cinereous: calyx 5.5–8 or 10 mm. long, canescent and viscid; sepals lance-oblong, acuminate: anther-sacs 1.2–1.3 mm. long.

In the Upper Sonoran Zone on the desert ranges from central Arizona to Southern California and adjacent Baja California, at elevations of 300 to 1500 meters. Type locality: "On Williams' Fork of the Colorado, New Mexico." (Probably Mohave or Yuma County, Arizona).

Arizona. Bill Williams Fork, Feb. 1853–4, *Bigelow* (GH, type; isotype NY). The type specimen is a poor scrap from which all the primary leaves have fallen leaving the young leaves fascicled in the axils, their bases (pulvini) white-pubescent. Gila County: Mescal Mts., May 24, 1890, *Jones* (A, C, M, Ph, Po, US); Christmas, *Peebles et al. 5188* (Ph, US); Roosevelt Dam, *Eastwood 6202* (A, CAS). Pinal County: Superior, *Harrison & Kearney 1481* (US). Yavapai County: Cottonwood Creek near Prescott, *Palmer 334* (C, F, M, NY, Ph, US); Skull Valley, Apr. 28, 1903, *Jones* (US); Congress Jct., May 4, 1903, *Jones* (Po). Maricopa County: Sierra Estrella, *Peebles et al. 3280* (US); Harquahala Mts., *Goldman 3008* (US). Mohave County: Chloride, Apr. 14, 1903, *Jones* (Po); Union Pass, May 30, 1893, *Wilson* (C, ND, RM); Oatman to Kingman, *Harrison & Kearney 7601* (F, US); Yucca, *Jones 3941* (A, C, CAS, F, NY, Ph, Po, RM, SU, US). California. San Bernardino County: Bonanza King Mine, Providence Mts., *Munz et al. 4059* (C, NY, Po, RM, SU, US); Kelso, May 2, 1906, *Jones* (Po, SU); Old Dad Mts., *Jones 25577* (M); Old Woman Mts., May 13, 1920, *Jones* (C, CAS, GH); Quail Springs, *Munz & Johnston 5239* (Po). Riverside County: Palm Springs, *Eastwood 2985* (CAS, US); Old Nicholas Canyon, Santa Rosa Mts., *Munz 5930* (Po). San Diego County: Palm Canyon, Borrego Valley, *Munz & Hitchcock 11347* (GH); Jacumba, *Mearns & Schoenfeldt 3223* (SU, US). Mexico. Baja California: 39 mi. W. of Mexicali, *Munz 9588* (C); N. W. slope, San Pedro Martir Mts., *Goldman 1203* (Ph, US).

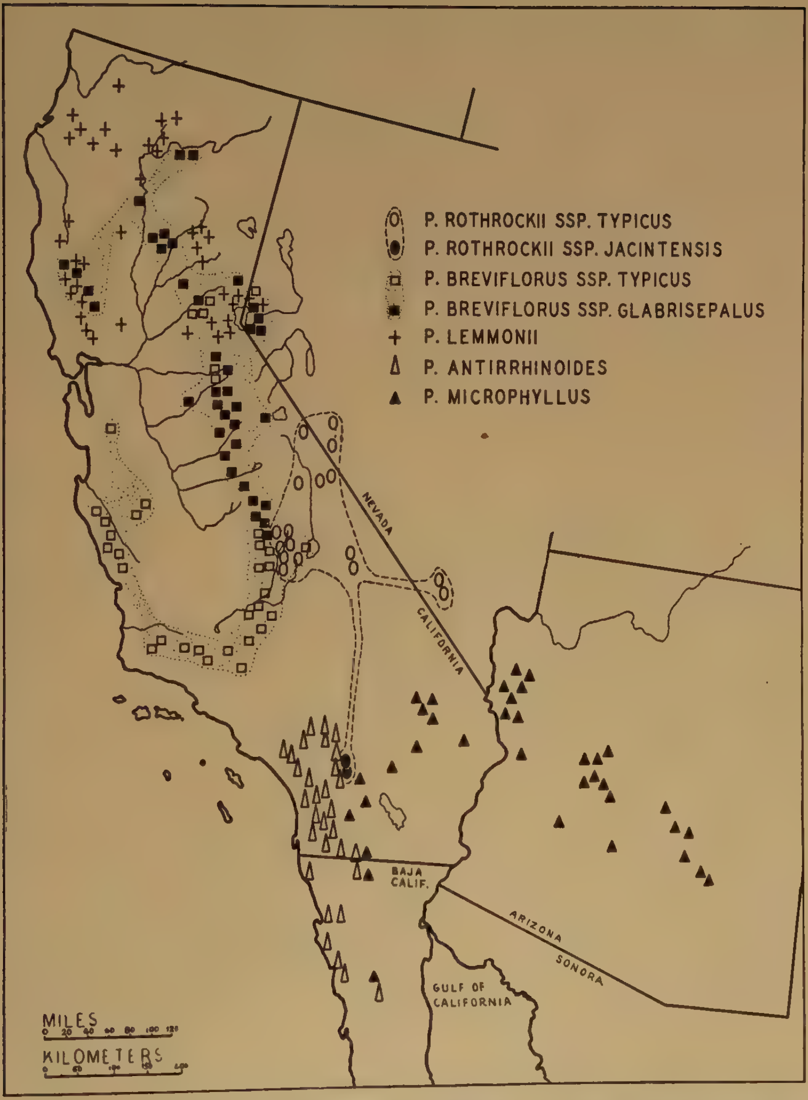

Fig. 1. Distribution of yellowish and whitish flowered species of section *Hesperothamnus*.

There is ample justification for retaining this as a species rather than following the lead of Munz and Johnston in reducing it to a subcategory under *P. antirrhinoides.* While the affinity of *P. microphyllus* and *P. antirrhinoides* is sufficiently obvious to tempt one for phylogenetic clearness to follow the latter course, it is also evident that these behave as distinct ecospecies, occupying quite distinct habitats, and exchanging genes only in the relatively narrow zone where cismontane climate meets desert and where species meets species.

6. Penstemon cordifolius Benth.

Penstemon cordifolius Benth. Scroph. Ind. Introd. 7, 1835.

Penstemon cordatus Walp., Rep. 3: 249. 1844–5. This is Bentham's name miscopied.

Scandent shrub 10–30 dm. high: herbage dark green, glabrous to lightly pubescent or hispidulous, more densely hairy and glandular within the inflorescence: leaves 15–35 mm. long, 10–20 mm. wide, lance-ovate to cordate, serrulate to sharply serrate: inflorescence a drooping compact thyrsus composed of many leafy cymules, with strongly divaricate or reflexed branchlets, 5–25 cm. long; peduncles 0.5–2 cm. long, 1–5-flowered: calyx 7–10 mm. long, densely glandular-pubescent; sepals lanceolate, acuminate: corolla dull scarlet, 30–40 mm. long, 5–7 mm. broad at throat, tubular; upper lip erect, 14–18 mm. long, not strongly keeled: sterile filament densely yellow-bearded for two-fifths its length, included: anther-sacs 1.2–1.6 mm. long.

Frequent on chaparral-covered slopes of the Upper Sonoran Zone in the coastal mountains below 1000 meters from San Luis Obispo County, California, southward to northern Baja California. Type locality: "New California," collected by Douglas.

California. *Douglas* (GH, isotype). San Luis Obispo County: Santa Margarita, July 12, 1911, *Brandegee* (C); Arroyo Grande, May 1895, *Sanford* (C). Santa Barbara County: Suey Creek, *Eastwood 386* (CAS); Gaviota Pass, *Abrams 6538* (SU); Santa Barbara, *Elmer 3956* (C, CAS, GH, M, NY, SU, US); Santa Rosa Island, June 1888, *Brandegee* (C); Santa Cruz Island, 1886, *Greene* (A, C, F, M, Ph, SU, US). Ventura County: trail to Nordhoff, *Dudley & Lamb 4813* (SU, US); Topatopa Mts., *Abrams & McGregor 150* (A, GH, NY, SU, US). Los Angeles County: Sepulveda Canyon, Santa Monica Mts., *Abrams 2545* (F, GH, M, NY, Ph, SU); Newhall, *Grinnell 460* (US); Claremont, *Baker 3441* (C, CAS, F, GH, M, NY, Po, US); Santa Catalina Island, *Heller 8951* (NY, US); San Clemente Island, *Trask 291* (A, US). San Bernardino County: Puente Hills, *Howell 2428* (CAS, CI); San Bernardino, *Parish 4181* (C, GH, M, NY, US). Riverside County: 12 mi. N. of Idyllwild, June 20, 1926, *Jones* (CAS, GH, Po, SU); Coldwater Canyon, Santa Ana Mts., *Hall 573* (C). San Diego County: Rincon Grade, May 29, 1926,

Jones (CAS, GH, NY, Po, SU); San Diego, *Brandegee in Baker 1616* (C, CAS, F, GH, M, NY, Po, RM, US); Jamul Valley, *Palmer 273* (C, F, M, NY). Mexico. Baja California: Tecate River near Monument 245, *Schoenfeldt 3758* (SU, US).

An interesting hybrid between this species and *P. antirrhinoides* Benth. has been collected by Carl V. Meyer, *no. 738* (C), on the Escondido-Moosa Canyon road, San Diego County.

7. Penstemon corymbosus Benth.

Penstemon corymbosus Benth. in DC. Prodr. 10: 593. 1846.

Shrub 3–5 (rarely to 10) dm. high: stems very woody, more or less glaucous: herbage deep green, canescent to glabrous: leaves 8–32 mm. long, 5–15 mm. wide, lance-oblong to broadly elliptical, entire to remotely serrate: inflorescence a terminal corymb, densely glandular-pubescent, 4–8 cm. long; peduncles seldom exceeding 1 cm. in length: calxy 6–9 mm. long; sepals linear-lanceolate to lance-ovate, acuminate or attenuate: corolla bright red or brick red, 25–35 mm. long, *ca.* 6 mm. broad at throat, tubular; upper lip erect, 11–13 mm. long, not strongly keeled: sterile filament densely yellow-bearded for its entire length, included: anther-sacs 0.9–1.1 mm. long.

Coast Ranges of California from Del Norte County to Monterey County, on rocky slopes and cliffs at elevations of 150 to 1500 meters. Type locality: California, probably in the Santa Lucia Mts., Monterey County.

The type number is *Coulter 629*. Bentham had no sheet of this in his herbarium but there was one in Herbarium Hookerianum from which, without doubt, his description was drawn. This sheet contains three twigs, the two lateral ones glabrous as to stems and leaves, the central one canescent. This would account for Bentham's statement "glaber vel pubescens" in the original description. A photograph and notes on this specimen taken by H. M. Hall at Kew have been examined. Isotypes of *Coulter 629* (GH, NY) are heavily pubescent on the leaves and stems of the several pieces represented. As it is desirable to distinguish a variety in this species on the presence or absence of pubescence, the type must be set as regards this character. Since Coulter's number includes both forms on the type sheet, we are permitted to choose the two pieces with glabrous leaves, which incidentally much better represent the true species even though Coulter collected predominantly pubescent material. The glabrous form is by far the more common in California. Moreover, Jepson has already given a varietal name to the pubescent form.

California. Del Norte County: Smith River, *Gale 380* (GH, M, Ph, US). Humboldt County: Jarnigans, July 10, 1888, *Chesnut & Drew* (C, US); Kneeland Prairie, *Tracy 3847* (C, NY, RM, US); Chaparral Mt. at Bug Creek, *Kildale 10357* in part

(SU). Mendocino County: Richardson Grove, Eel River, *Heller 13860* (F, M, NY, SU, US); between Lanes Redwood Flat and Coolidge Memorial Park, *Keck 2680* (C, CI, SU); Blue Rock Station, *Kellogg & Harford 679* (CAS, GH, NY, US). Lake County: Middle Creek, foot of Elk Grade, Aug. 1892, *Jepson* (C). Sonoma County: Austin Creek, *Davy & Blasdale 6009* (C). Marin County: Mount Tamalpais, *Eastwood 1536* (GH, NY, US). Contra Costa County: Mount Diablo, *Elmer 4956* (C, CAS, M, NY, SU, US). Santa Clara County: Loma Prieta, *Elmer 4980* (SU); Mount Hamilton, *Howell 11502* (A, CAS, CI). San Benito County: Hepsedam Peak, June 2, 1899, *Dudley* (SU). Monterey County: Point Sur, July 1888, *Brandegee* (F).

7a. Penstemon corymbosus var. puberulentus Jepson

Penstemon corymbosus var. *puberulentus* Jepson, Man. Fl. Pl. Calif. 909. 1925.

Penstemon intonsus Heller, Muhlenb. 1: 44. 1904. Type: "No. 6020, collected August 1, 1902, along Eel river near Hullville, Lake County, California" (Heller). This lightly puberulent form is described as new because of the bearded staminode, Bentham having erroneously described the sterile filament of *Coulter 629* as glabrous.

With the species but less frequent; also to Shasta and Butte counties. Type locality: "Butte Co. (Richardson Sprs., Hall 6763, type)."

California. Shasta County: Cottonwood Canyon (near Shasta), *Brewer 1337* (C, GH, US). Butte County: Richardsons Springs, *Hall 6763* (C, type; isotypes GH, NY, US). Siskiyou County: Klamath River, 4 mi. below Happy Camp, *Wolf 1125* (SU). Trinity County: Mount Bolly, Sept. 27, 1879, *Kleeberger* (CAS). Humboldt County: Somes Bar, Klamath River, *Chandler 1516* (C); Chaparral Mt. at Bug Creek, *Kildale 10357* in part (SU). Lake County: Eel River, Hullville, *Heller 6020* (GH, M, NY, Ph, RM, SU, US, isotypes of *P. intonsus*); summit Mount Sanhedrin, July 28, 1902, *Heller* (GH, M, NY, Ph, US); between Bartlett Springs and Clear Lake, *Abrams 6287* (A, NY, RM, SU). Monterey County: Tassajara Hot Springs, Oct. 2, 1921, *Clemens* (CAS); W. of Twin Peaks, Santa Lucia Mts., Aug. 1, 1903, *Dudley* (NY, SU).

Pubescence on the stems and foliage seems to have no selective value in this species. While the farthest inland stations (Butte County and Shasta County) produce pubescent individuals, the same type occurs freely in the Coast Ranges with the glabrous form. The two forms have almost completely overlapping ranges, as shown in figure 2, and intergrades between them are frequent. Since there is no geographic segregation evident, which if present would indicate that a phylogenetically

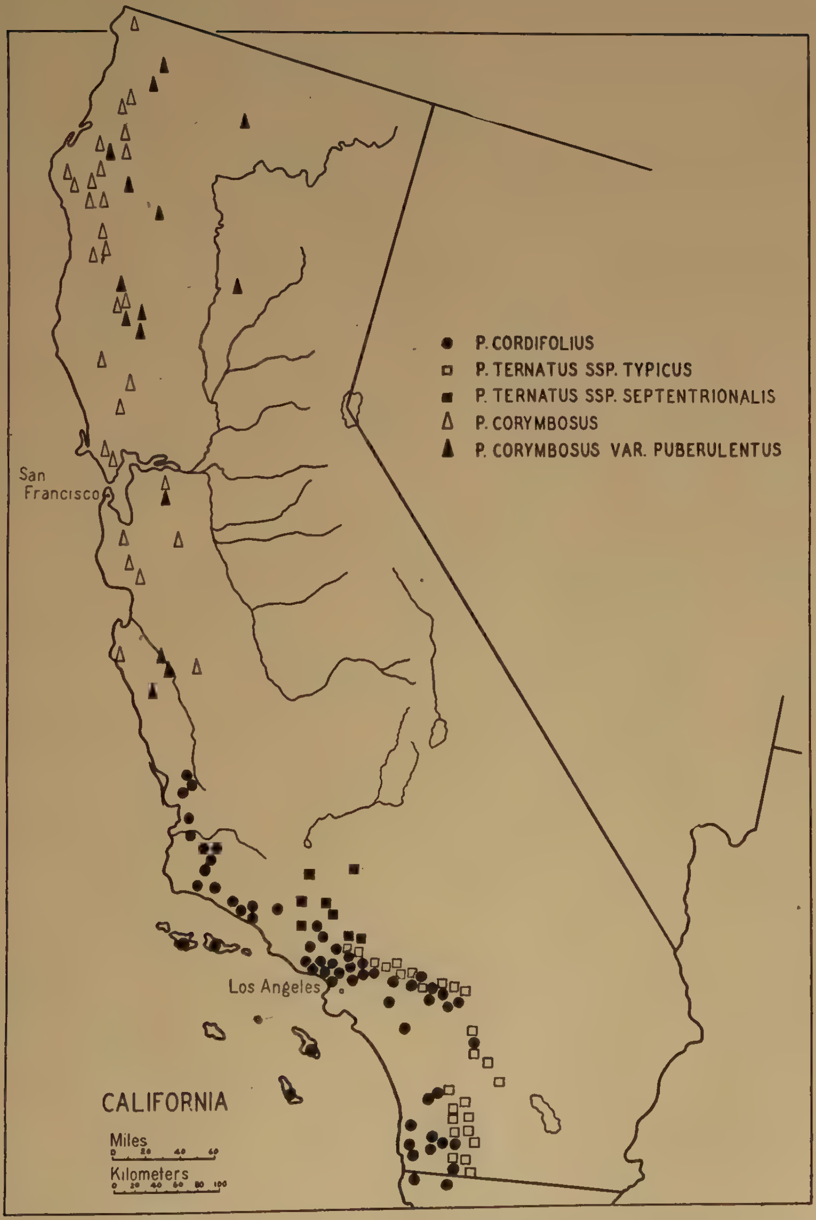

FIG. 2. Distribution of the red-flowered species of section *Hesperothamnus*.

valuable character with survival value was involved, the pubescent type can only attain to varietal rank.

8. Penstemon ternatus Torr.

Penstemon ternatus Torr. in Gray, Bot. Mex. Bound. 115. 1859.

Shrub 5–15 dm. high, the wandlike glaucous stems sometimes scandent, glabrous: leaves bright green, glabrous, 1–5 cm. long, 2–9 mm. wide, linear-lanceolate, tapering to base and apex, ternate (rarely opposite), remotely serrulate: inflorescence a racemose panicle, glabrous (except in subsp.), 7–30 or 50 cm. long; peduncles up to 2 cm. long: calyx 3–5 mm. long; sepals lance-ovate, acuminate: corolla scarlet, 23–30 mm. long, *ca.* 5 mm. broad at throat, tubular; upper lip erect, 5–6 mm. long, not strongly keeled: sterile filament densely bearded for its entire length, well included: anther-sacs 1 mm. long.

Southern California and northern Lower California.

8a. Penstemon ternatus subsp. typicus nom. nov.

Frequent in chaparral in the Upper Sonoran and Transition zones of the coastal drainage from the San Gabriel and San Bernardino mountains southward to San Pedro Martir, Baja California, at elevations of 300 to 2000 meters. Type locality: "Mountains east of San Diego; June; *Parry*."

California. Los Angeles County: Pacoima Canyon, *Ewan 4741* (GH); Tejunga Canyon, *Braunton 1275* (C); Prairie Fork, San Gabriel River, *Johnston 1676* (Po, RM, SU); Claremont, *Baker 5067* (C, NY, Ph, Po, SU). San Bernardino County: Cajon Pass, *Abrams & McGregor 698* (NY, SU, US); San Bernardino, *Parish 4183* (C, CAS, GH, NY, US); Seven Oaks, *Munz 12661* (A, C, Po); Clark's Ranch, *Abrams 2939* (GH, NY, Ph, SU, US). Riverside County: Chalk Hill, San Jacinto Mts., *Hall 2634* (NY, Ph, SU, US); Santa Rosa Mts., *Munz 5852* (Po). San Diego County: Palomar Mt., *Chandler 5441* (C, NY); Warners Hot Springs, 1911, *Coombs* (CAS, US); Potrero to Cottonwood Valley, *Abrams 3726* (A, GH, NY, Ph, SU, US); Descanso, *Spencer 919* (GH, Ph). Mexico. Baja California: Guadalupe Mt. June 1, 1883, *Orcutt* (Carnegie Museum, Pittsburgh); San Pedro Martir, May 6, 1893, *Brandegee* (C).

8b. Penstemon ternatus subsp. septentrionalis (Munz et Johnst.) comb. nov.

Penstemon ternatus var. *septentrionalis* Munz et Johnst. Bull. So. Calif. Acad. Sci. 23: 28. 1924.

In mountains to the northwest of subsp. *typicus,* largely on drainages not facing the coast, in adjacent portions of Kern, Ventura, and Los Angeles counties. Type: "Abrams & McGregor 394, Oakgrove Canyon, Liebre Mts. (GH)."

California. Kern County: Tehachapi, 1895, *Davidson* (C); Fort Tejon, *Xantus 63* (GH, NY, US). Ventura County: Mount Pinos, below Mutau Flat, *Dudley & Lamb 4769* (SU, US); Redreef Canyon, *McMinn 1120* (SU). Los Angeles County: Sandbergs, Liebre Mts., *Munz 4418* (Po); Oakgrove Canyon, Liebre Mts., *Abrams & McGregor 394* (type, GH; isotypes, NY, SU, US); Soledad Canyon, *Braunton 1011* (Ph); Acton, Mount Gleason, *Elmer 3597* (C, CAS, GH, NY, SU, US).

Discussion on Phylogeny and Specific Delimitation

The distributions of the various units in the section *Hesperothamnus* are depicted on the accompanying distributional maps. In figure 1 the five species with brownish, white, or yellow flowers are mapped; these are insect-pollinated, bumblebees perhaps acting as the chief agents of pollination. In figure 2 the three species with red tubular flowers are located and these species are visited regularly by humming birds. If we follow the dictum that humming bird-pollinated species are derived from the insect-pollinated, the red-flowered species should be the last ones treated, as they are in this classification.

Penstemon Rothrockii is taken up first and its relatively simple corolla would indicate its merit for this position. Also, the spicate inflorescence is much less complicated in this species than in the others, and the fact that the flowers are often alternate instead of opposite toward the summit of the inflorescence would indicate a primitive rather than a derived type. The discontinuity of its distribution is brought out in figure 1, and it is to be noted that with the exception of the water-shed toward the headwaters of the Kern River, its distribution is to the east of the Sierran crest. A peculiarity by which this species differs from many others that occur both in the southern Sierra Nevada and the mountains of southern California is that *P. Rothrockii* subsp. *jacintensis* has not been discovered in the San Bernardino Mountains. While *P. Rothrockii* occurs on mountain chains of a desert region, it is at high elevations.

Penstemon breviflorus breaks up into two subspecies with very natural distributions. Subspecies *typicus* occurs in the South Coast Ranges and into the southern Sierra Nevada by way of the Tehachapi Mountains and adjacent ranges. This has a glandular-pubescent calyx, which is in correlation with its distribution through the warmer southern ranges, while subsp. *glabrisepalus*, lacking this pubescence, occurs in a cooler district through the central Sierra Nevada north to Shasta County and into the North Coast Range. From the Lake Tahoe region to Tulare County, a certain proportion of subsp. *typicus* occurs with the much more predominant subsp. *glabrisepalus* and here hybridization occurs.

Penstemon Lemmonii is confined to the mountains of northern California where it is found in less exposed situations than its

near relative, *P. breviflorus.* The inflorescence of the former is the more complicated, its numerous peduncles terminated by many-flowered corymbs.

The close affinity between *P. antirrhinoides* and *P. microphyllus* has been touched upon. A glance at the map shows their geographic relations. The former is found in the coastal mountains; the latter in the interior. The morphological differences between the species reflect the selective powers of the different climates under which they grow. The distribution of these two species suggests that the pallid, canescent herbage and viscid-pubescent calyx that aid in distinguishing *P. microphyllus* either are characters of survival value or are linked to physiologic characters of importance for survival in this climate. Such characters indicate that each of these is a species selected by the environment, a natural species, or again, an ecospecies to use the apt term of Turesson.

Penstemon antirrhinoides and *P. microphyllus* stand a little to one side of the phylogenetic line that appears to connect the first three species mentioned.

Turning to figure 2, it will be observed that *P. cordifolius* is rather strictly a coastal species occurring in chaparral of the lowlands. On the islands it develops extra large leaves, but similar forms occur at the northern and southern extremities of its range, as well as at other points, so this character is too erratic for use in subdivision of the species.

Penstemon ternatus is shown to be somewhat farther removed from the coast and higher in the mountains, but it too is found in chaparral. The southern subspecies, *typicus,* is confined to the western and southern sides of the higher ranges, but its northern subspecies, *septentrionalis,* with added glandular-pubescence within the inflorescence, occurs in the Tehachapi and Liebre mountains and the Mount Pinos region where the thermostatic influence of the ocean is less pronounced. The ternate leaves of this species are very unusual in *Penstemon,* but here again the affinities within the section are demonstrated, for ternate leaves occasionally are found in *P. cordifolius.*

Penstemon corymbosus occurs wholly to the north of the other red-flowered species. Its chief center of distribution is in the belt of the coast redwoods, but it also penetrates the Inner North Coast Range freely. There is a tendency for var. *puberulentus* to occur in more arid situations farther toward the interior than does the glabrous genuine form, but field studies confirm the impression gathered in the herbarium that the two occur together and intergrade much too freely to accord the variety subspecific rank. The fact that both extend the entire length of the range should be considered also and calls for the explanation that the variety deserves to be recognized, because the character involved is for the most part clear-cut and even outstanding.

These three red-flowered species have individual specializations: the inflorescence of *P. corymbosus* seems certainly to be derived from the paniculate type; the pendant inflorescence of *P. cordifolius,* with the correlated twisting of the flowers to arrange themselves normally, is peculiar to this species as is the definite scandent habit. *P. ternatus* has some tendency to be scandent too and has specialized ternate branching and leaves; its corolla, too, is the most narrow found in this section.

The connections between the red-flowered species and the others seem to occur between *P. antirrhinoides* and *P. cordifolius,* which hybridize, which have a rather similar robust habit, and which occur in the same region; also, between *P. breviflorus* and *P. ternatus,* which mimic each other's habit but are probably not in a direct line of descent; and between *P. Lemmonii* and *P. corymbosus,* whose habital similarities are probably due more to their common occurrence in the moister northern mountains than to a close phylogenetic relationship.

Carnegie Institution of Washington,
Stanford University, October 4, 1935.

NEW AND NOTEWORTHY NORTHWESTERN PLANTS—VI[1]

Harold St. John

Juncaceae

Luzula campestris (L.) DC. var. columbiana St. John var. nov. Planta viridis cristata, caulibus paucis vel pluribus 16–48 cm. altis; foliis 2–4 mm. latis quam caules valide brevioribus, foliis caulinis 2–3 similaribus villoso-ciliatis ad basin; bracteis inferioribus quam inflorescentias brevioribus vel superantibus; capitulis 1–5 ovatis vel cylindraceis 10–30-floriferis 6–11 mm. longis, capitulis terminalibus breve pedunculatis, capitulis lateralibus cum pedunculis 1.5–6.5 cm. longis; bracteis florum pallidis hyalinis ovato-lanceolatis acuminatis laceratis; sepalis 2–2.5 mm. longis plerumque atro-brunneis lanceolatis acuminatis ad marginem hyalinis; petalis latioribus; fructibus ovali-trigonis atro-brunneis vel atrescentibus ad apicem 2–2.5 mm. longis.

Plants bright green, tufted; stems few to several, 16–48 cm. tall; basal leaves much shorter than the stems, 2–4 mm. broad; cauline leaves 2–3, similar, villous ciliate at base; lowest bract shorter than or exceeding the inflorescence; heads 1–5, ovate to short cylindric, 10–30-flowered, 6–11 mm. long, the terminal one short stalked, the lateral ones on slender rays 1.5–6.5 cm. long; floral bracts pale, hyaline, ovate-lanceolate, acuminate, lacerate;

[1] Contribution No. 50 from the Department of Botany, State College of Washington.

perianth 2–2.5 mm. long, dark brown or largely so; sepals lanceolate, acuminate, hyaline margined; petals broader towards the tip; capsules oval-trigonous, dark brown to blackish at tip, equaling the perianth.

WASHINGTON: good soil, shady places, 5300 feet, Wenatchee Mts., Kittitas Co., July 1, 1903, *J. S. Cotton 1277;* in meadows, Falcon Valley, May 28, June, 1892, *W. N. Suksdorf 2118.*

OREGON: open woods, 4500 feet, Government Camp, Mt. Hood, Hood River Co., July 3, 1926, *Carl English, Jr., 83* (type, in Herb. State College of Washington); bogs, 4500 feet, Government Camp, Mt. Hood, July 4, 1926, *Carl English, Jr., 159;* near water, Mirror Lake, 4500 feet, Mt. Hood, Clackamas Co., Aug. 3, 1927, *C. English, Jr., 722, 873.*

The varietal name is taken from that of the Columbia River, which, with its tributaries, receives the drainage from all of the mountainous areas here listed.

The closest relative of this new variety is doubtless *Luzula campestris* (L.) DC. var. *alpina* Gaud.—var. *sudetica* (Willd.) Celak.—of Hudson Bay and of the mountains of Eurasia. It has the heads ovate, scarcely 5 mm. long, mostly 5–8-flowered, often all sessile or 1–2 lateral heads short stipitate. On the contrary, *L. campestris* (L.) DC. var. *columbiana* St. John has the heads ovate to short cylindric, 6–11 mm. long, 10–30-flowered, and the lateral heads on rays 1.5–6.5 cm. long.

In a recent discussion of this species and its varieties,[2] Theo. Holm indicates certain differences between *L. campestris* and its variety *multiflora* and concludes that the latter should be maintained as a species and that the American varieties should be referred to the latter species. He does not present a revision of the group or make the nomenclatorial transfers, but merely leaves it as a suggestion. The writer is familiar with several of the varieties and is ready to accept them as variations of one wide-spread, polymorphic species. This was essentially the view of Buchenau[3] and of Fernald and Wiegand.[4] The botanists of Western North America have mostly neglected or rejected these treatments. The writer calls attention to their clear presentation of taxonomic entities based on adequate characters and with natural geographic ranges.

For instance, in the state of Washington, four varieties of *L. campestris* are now known to occur. They may be separated by the following key:

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[2] Holm, Theo. The bulbiferous form of *Luzula multiflora.* Rhodora 28: 133–138. 1926.

[3] Buchenau, Fr. Juncaceae, in Engler, A., Pflanzenreich IV. 36: [*Luzula campestris*] 83–95. 1906.

[4] Fernald, M. L. and Wiegand, K. M. The Variations of *Luzula campestris* in North America. Rhodora 15: 38–43. 1913.

KEY TO VARIETIES OF LUZULA CAMPESTRIS (L.) DC.

Perianth 2–2.5 mm. long	*L. campestris* var. *columbiana*
Perianth longer (2.5–4.5 mm.).	
Inflorescence congested, with no obvious rays	*L. campestris* var. *congesta*
Inflorescence looser, the lateral spikes on obvious rays.	
Heads mostly cylindric, the larger 10–30 mm. long; perianth usually pale, 3–4.5 mm. long	*L. campestris* var. *comosa*
Heads globose or short cylindric, 4–11 mm. long; perianth dark brown to blackish, 2.5–3 mm. long . .	*L. campestris* var. *frigida*

Since stations in Washington for the three latter varieties have not been listed, it is worth while to give them here.

L. CAMPESTRIS var. COMOSA (Meyer) Fern. et Wieg. Rhodora 15: 41. 1913. At middle and low elevations, common and widely distributed in the state. Only two collections need be cited. Whidby Island, *Gardner 301;* Kamiack Butte, *Elmer 805.*

L. CAMPESTRIS var. CONGESTA (Thuill.) Meyer, Synop. Luz. 18. 1823. Near Skagit Pass, Cascade Mts., *Lake & Hull 415.*

L. CAMPESTRIS var. FRIGIDA Buch. Oesterr. Bot. Zeitschr. 48: 284. 1898. Stuart Island, *Lawrence 98;* Columbia River, western Klickitat Co., *Suksdorf 2100.*

ERICACEAE

PYROLA UNIFLORA L. var. **reticulata** (Nutt.) St. John comb. nov. *Moneses reticulata* Nutt. Trans. Am. Phil. Soc. II, 8: 271. 1843. *M. uniflora* (L.) Gray var. *reticulata* (Nutt.) Blake, Rhodora 17: 28. 1915.

The characters used to separate *Moneses* as a genus from *Pyrola* have been reviewed. The one-flowered habit and the spreading position of the petals seem to the writer valueless. The capsule dehisces from the tip down, and the edges of the valves are cobwebby. These are characters of some value, but to the writer they do not appear to be of generic value, nor did they to Drude in Engler and Prantl.

University of Hawaii,
Honolulu, June, 1935.

REVIEW

An Illustrated Manual of Pacific Coast Trees. By HOWARD E. MCMINN and EVELYN MAINO. Pp. xii + 409, with 415 figures. Published by University of California Press, 1935. $3.50.

One of the important gaps in the development of botany in North America is the lack of popular works accurate and com-

plete as to detail, but written with a view of stimulating the interest of the layman in plants. Producing such a work is by no means an easy task, as it calls for an insight into the problem not characteristic of most botanists. "An Illustrated Manual of Pacific Coast Trees" by Professor Howard E. McMinn and Evelyn Maino, both of Mills College, is admirably planned to accomplish this purpose, and it should fill a long felt need of the people of the Pacific Coast who are interested in trees. It deals with the native trees as well as those cultivated sufficiently to be frequently encountered. The area covered is that of California, Oregon, Washington, and British Columbia. The work is of hand-book size, conveniently bound in a flexible cover, is excellently printed, and is well illustrated with line drawings and photographs.

Included in the introduction is a brief discussion of leaf types and arrangement, the flower, the fruit, the seed, and an explanation of botanical terminology. The origin and distribution of the native and introduced trees are reviewed, and the life zones of the region are summarized. In addition to the material contained in the introduction, there is a glossary of botanical terms, a section in which additional native species which are occasionally tree-like are listed, and a bibliography of some forty titles. Of special interest to many is the section compiled by Professor H. W. Shepherd, Division of Landscape Design, University of California, consisting of a list of trees recommended for various uses under cultivation.

This manual differs from many in general use in that the key to genera is based largely upon leaf characters. This key is the product of many years development as Professor McMinn has built it up in connection with his teaching. As it now stands the key is exceedingly practical and certainly justifies the time spent. For the most part, the arrangement of the families in the body of the text follows the system of Engler and Prantl, but within the families the genera are arranged alphabetically. In addition to brief descriptions in which the distinguishing characters are stressed, the distribution and economic notes of interest are given for each species.

The nomenclature follows that recommended by the American joint committee on horticultural nomenclature published in "Standardized Plant Names." For those plants not taken up in this work, strict botanical usage is followed. This is open to some objection in that a dual system of authority enters. It seems to the reviewer that some effort should have been made to bring strict botanical usage into popular favor.

The book is well worth the consideration of botanists and laymen interested in Pacific Coast trees.—H. L. M.

NOTES AND NEWS

Several important phytogeographic and floristic surveys of definite areas in Western North America are in progress.

Among these should be mentioned the intensive study of the Sonoran Desert being undertaken jointly by investigators at Dudley Herbarium of Stanford University and the Desert Laboratory of Carnegie Institution at Tucson, Arizona. The area included in these investigations is the western portion of Sonora, southwestern Arizona, the Colorado Desert region of California and eastern and central Baja, California, reaching the Pacific Ocean only at Viscaino Desert. Some 2500 species of flowering plants are thought to be included in this area.

Mr. Elmer I. Applegate, Honorary Curator of Dudley Herbarium, is engaged in preparing accounts of the floras of the following areas: Crater Lake National Park, Klamath County, Oregon; Oregon Caves National Monument, Josephine County, Oregon; Lava Beds National Monument, Modoc and Siskiyou counties, California.

Dr. Edward H. Graham, Carnegie Institution Museum, Pittsburgh, has been studying since 1931 the flora of the Uinta Basin in northeastern Utah and northwestern Colorado. He has just completed his third season in the field. This is one of the few large areas in arid Western America which remain, from the biological point of view, relatively unknown.

Dr. Harold St. John is pursuing his study of the flora of the Palouse Region in southeastern Washington and adjacent Idaho with the intent of providing an up-to-date account of this region which is approximately the same as that covered by Piper and Beattie's "Flora of Southeastern Washington and Adjacent Idaho," published in 1914 and long since out of print.

Dr. E. B. Copeland, Technical Adviser and Agricultural Botanist in Charge of the Economic Garden, Los Baños, Laguna, arrived in Berkeley from the Philippine Islands in June, 1935. For the next few months, he will continue research on the oriental pteridophytes at the University of California herbarium.

Dr. C. Leo Hitchcock of the Department of Botany, University of Montana, spent the summer months in research work at several botanical institutions of eastern United States. In September he spent a few days at the University of California herbarium at Berkeley.

Dr. Phillip A. Munz of the Department of Botany, Pomona College, Claremont, California, spent the greater part of the summer at Gray Herbarium, Harvard University in pursuance of his studies on the California flora.

Mr. John Wilkinson, Commonwealth Fund Fellow, has arrived in Berkeley, from Armstrong College, University of Durham, England. Mr. Wilkinson, who has been studying the genus Salix from a cyto-taxonomic viewpoint, will continue research at the University of California.

PROCEEDINGS OF THE CALIFORNIA BOTANICAL SOCIETY

Saturday, April 6, 1935. A field trip was taken to Big Basin in the Santa Cruz Mountains. The group met at 10:00 a.m. in Room 460, Physiology Building, Stanford University, and proceeded by automobile to Big Basin, arriving for lunch at about noon. Attendance was small on account of rain. However, a larger number arrived for dinner at Students' Union, Stanford University, and the evening lecture, Room 460, Physiology Building, was well attended. Dr. Ira L. Wiggins of Stanford University spoke on "Botanizing in Sonora." This account of a recent field trip was illustrated. President George J. Peirce occupied the chair. No business was transacted.

Thursday, October 17, 1935. A meeting was held at 8:00 p.m. in Room 2093, Life Sciences Building, University of California, Berkeley. The President, Dr. George J. Peirce, occupied the chair, introducing Professor G. W. Hendry of the Division of Agronomy, College of Agriculture, University of California, Berkeley. Professor Hendry gave an illustrated lecture on "The Botanical Analysis of Adobe Bricks." The identification of the various grain and weed seeds found in adobes of known date of the Spanish-Californian period yields much information about the kinds of grain cultivated by the Spanish-Californians and also fixes the approximate dates of introduction of many alien plants which have become naturalized in California. About sixty-five members and guests attended the meeting. No business was transacted.

Thursday, November 21, 1935. A meeting was held at 8:00 p.m. in Room 2093, Life Sciences Building, University of California, Berkeley. Professor Emanuel Fritz, Second Vice-President, occupied the chair, introducing the speaker, Professor W. F. Gericke, of the Division of Plant Nutrition, College of Agriculture, University of California, Berkeley. Professor Gericke spoke on "Crop Production in Liquid Media." The commercial possibilities of this method of water culture were demonstrated by comparing yields and cost of production with those of the usual soil culture method. Very convincing slides illustrated the lecture. About fifty-five members and guests attended the meeting. No business was transacted.—E. Crum, Secretary.

NATURAL GARDENS OF THE WASATCH—I

J. W. McKay

Rock Gardens

The Wasatch range of mountains extends north and south almost the entire length of the state of Utah, and forms an important part of the Rocky Mountain system generally known as the intermountain country. The character of the vegetation in these mountains varies from that of a desert sagebrush slope at near 5000 feet to typical alpine meadow at above 10,000 feet elevation. Many parts of the range have not been thoroughly explored for plants and much work is yet to be done before an adequate knowledge of the species occurring here will be available.

Certain species play an important rôle in the vegetation of this mountain area and give to it a characteristic appearance. In this, as in many of our western areas, the increase in grazing operations is a factor in denuding much of the soil of its native vegetation. The botanist, agriculturist or layman interested in observing undisturbed areas of vegetation finds it increasingly difficult from year to year to do so. The following account will deal with a description of certain natural, undisturbed, rocky areas which the writer has visited and studied during the past season. It is impossible, of course, to mention all of the species occurring in these localities, and comment is restricted to those characteristic of the vegetation or to those of striking appearance.

In one particular area which was visited several times during the season a colorful effect was created about midsummer by the following species in bloom: *Castilleja linariaefolia* Benth., *Pentstemon humilis* Nutt., *Sedum stenopetalum* Pursh and *Allium acuminatum* Hook. The first-named species is a fine representative of the Indian paint-brush tribe, and it really paints the rocky terrain with its clumps of brilliant scarlet color. *Pentstemon humilis* is a dwarf, small-flowered member of this genus, but its habit of growing in dense clumps enables the plant to add its delicate shade of blue to our natural flower garden. *Allium acuminatum,* a lavender-flowered onion one foot high, and the bright yellow-flowered *Sedum* occupy a less conspicuous part in this picture, but upon closer inspection the crevices and pockets between the rocks are found to contain many individuals of these two species. Intermingling with the above but in smaller quantity are clumps and individual plants of *Pentstemon cyananthus* Hook., *Gilia aggregata* (Pursh) Spreng., *Linum lewisii* Pursh and the state flower of Utah, the sego lily, *Calochortus nuttallii* Torr. and Gray.

Another area showed earlier in the season great masses of *Phlox canescens* Torr. and Gray and *Phlox stansburyi* (Torr.) Heller.

Madroño, vol. 3, pp. 225–256, April 13, 1936.

Other species in flower at this time include the attractive little bulbous plants *Erythronium grandiflorum* Pursh, *Brodiaea douglasii* Wats., *Fritillaria pudica* (Pursh) Spreng., *Fritillaria atropurpurea* Nutt., and the bright blues and reds of *Delphinium menziesii* DC. and *Castilleja angustifolia* G. Don respectively. Many of these species deserve to be better known to the scientific and gardening public than they have been in the past. It may be said, in general, that areas of this type offer unusual opportunities to the scientist in his attempt to gain a better understanding of the vegetation, as well as to the rock garden fancier who desires hardy and attractive species which will add character and native charm to his garden. *Pentstemon cyananthus,* mentioned above, is an example of a species that undoubtedly will enjoy wide popularity when its beauty and ease of culture become generally known. The writer has never seen a more beautiful spectacle than a rocky slope entirely covered with a mass of these plants, the tall two-foot spikes of clear sky-blue flowers painting the landscape with their color.

Fig. 1. *Petrophytum caespitosum* on perpendicular cliff, two miles east of Logan, Utah. Approximately one-eighth natural size.

An account of the rock plants of this region would be incomplete without reference to what is perhaps the most characteristic species. Even the name of this plant, *Petrophytum caespitosum* (Nutt.) Rydb., a member of the rose family, suggests its preference for growing on rocks. The accompanying photograph gives an idea of the habit of growth of this plant. The prostrate branches are spread over perpendicular rock faces and the roots find footholds in crevices or depressions. By forming a dense mat of branches and leaves, an accumulation of rock particles and dead plant remains is soon gathered which in time provides a rich humus soil for the roots. A single plant may be from four to six

feet across, and the woody trunk at the base of the plant may measure three to four inches in diameter. The writer has tried to estimate the age of such an individual by counting the growth rings in the wood, but this is difficult since, as a consequence of very slow growth, little wood is laid down each year. The plant blossoms much after the fashion of *Acaena* or related genera, sending up, in late summer, small attractive spikes of rather inconspicuous white flowers.

It is hoped that a discussion of certain species characteristic of the vegetation of this area may be of value in calling attention to a few aspects of the flora that are perhaps not widely recognized. Many problems of a distributional nature are to be encountered in this region since it is a meeting place, so to speak, for floras of more or less distinctive adjacent areas. The intermountain region offers, therefore, a fine opportunity for a study of field botany from several points of view, particularly those dealing with origin, movement and distribution of native species.

Utah State Agricultural College,
Logan, November, 1935.

NOTES ON CALIFORNIA GRASSES

Robert F. Hoover

During the spring and summer of 1935 collections were made by the writer in the San Joaquin Valley. Among these were many grasses found beyond their previously known range, and a few apparently distinct from anything yet described.

Festuca confusa Piper. Vernalis, San Joaquin County, March 1, 1935, *Hoover 239*. This is to my knowledge the first record for the Great Valley although the species is frequent throughout central California, in both the Coast Ranges and the Sierra Nevada.

Festuca pacifica Piper, Contr. U. S. Nat. Herb. 10: 12. 1906. Rarely collected in the valley, but very common in many places, though never where the soil has been cultivated. The spikelets in most localities show all gradations from entirely glabrous or minutely scabrous to distinctly hairy.

Festuca pacifica Piper var. **ciliata** (Gray) Hoover comb. nov. *Festuca microstachys* Nutt. var. *ciliata* Gray; Beal, Grasses N. Amer. 2: 585. 1896. Quite common along the east side of the San Joaquin Valley, and on the west side at the north. Wherever I have found this variety, it intergrades completely with *Festuca pacifica* Piper: Madera (5 miles southeast), Madera County, March 30, 1935, *Hoover 475* and *476*. Collections from other regions including similar intergrading forms are the following: North Fork Eel River, Mendocino County, May 3, 1933, *Duran*

3395a; Trinity County, *Tracy 7005;* Kings River, July, 1902, *Lemmon.*

Festuca pacifica Piper var. **simulans** Hoover var. nov. Planta plerumque altior, 20–60 cm. alta; spiculis reflexis, 3–6 Fresno County to Kern County, where it is the dominant native floribus, saepissime glabris, vel interdum glumis pubescentibus, rarius etiam lemmatibus.

Abundant on the west side of the San Joaquin Valley from grass. Type collection: Blackwell's Corner (2 miles north), Kern County, March 30, 1935, *Hoover 451* (Univ. Calif. Herb. no. 534130). Other representative collections are: Wasco (35 miles west), Kern County, April 7, 1926, *Munz 10105;* near Kettleman City, Kings County, March 30, 1935, *Hoover 442a.*

These plants have been referred to *F. reflexa* Buckl. and *F. microstachys* Nutt., which differ in having one to three flowers to a spikelet. The number of flowers in the spikelets, in which this variety resembles *F. pacifica,* seems to be a good specific character and of more importance than the reflexed spikelets. There is also a slight but significant difference in the glumes and in the shape of the lemmas between the *F. microstachys* and the *F. pacifica* groups. Furthermore, some specimens are intermediate between *F. pacifica* and var. *simulans*: Huron, Fresno County, March 23, 1893, *Eastwood;* Oro Loma (2 miles east), Fresno County, March 29, 1935, *Hoover 402.* A plant which is abundant at Bakersfield (April 26–May 30, 1896, *Davy 1898*) may belong here, but since I have not seen fresh specimens the number of flowers is uncertain because the spikelets break up on drying. In *F. pacifica* var. *simulans* as here described, the pubescence of the spikelets is too inconstant to justify even a separate varietal name based on that character. The type collection shows all degrees of pubescence. *F. pacifica* and its varieties may be distinguished by the following key.

Key to Varieties of Festuca pacifica

Spikelets all divergent at maturity .... *F. pacifica* var. *simulans*

Only principal panicle branches divergent.
- Spikelets glabrous or scabrous .... *F. pacifica*
- Spikelets pubescent .... *F. pacifica* var. *ciliata*

Puccinellia maritima (Huds.) Parl. Flood-plain of Little Panoche Creek, western Fresno County, March 29, 1935, *Hoover 477,* growing in alkaline (gypsum) soil. The only other California collection seen is from Haywards, Alameda County, June, 1915, *W. H. Nixon.* Both agree well with the following collections: Sitka, Alaska, July, 1891, *W. G. Wright 1585, 1593;* Farsund, Norway, July, 1884, *Murbecke;* "hab. in paludosis, ad ripas

fl. Lukos, juxta el Araix, 1 majii 1930," *Font Quer 62* (Morocco).

Anthochloa colusana (Davy) Scribn. *Stapfia colusana* Davy, Erythea 6: 110, pl. 3. 1898. Near Waterford, Stanislaus County, on the road to Oakdale, in dry beds of vernal pools, July 27, 1935, *Hoover 695.* This species has previously been known only from the type collection: "Goose-lands" near Princeton, Colusa County, May, 1898, *Davy* (Univ. Calif. Herb. no. 38962). Although the type is from an alkaline region, the soil at the present locality does not contain an appreciable amount of alkali.

Orcuttia inaequalis Hoover sp. nov. Planta omnino pilosa; caulibus erectis vel ascendentibus, multis e basi, 2–15 cm. altis; spiculis 4–10 mm. longis, vel denique 2.5 cm. longis; lemmatibus 3–4 mm. longis, 5-dentatis; centrali dente subulato, reliquiis dentibus latioribus et brevioribus, duo interioribus lateralibusque dentibus longioribus quam exterioribus.

Confined to a narrow zone about half a mile wide and thirty miles long from Waterford, Stanislaus County, nearly to Merced, growing in dry beds of vernal pools. Type collection: Montpellier, Stanislaus County, May 28, 1935, *Hoover 582* (Univ. Calif. Herb. no. 534128). In a later collection from the same locality, July 22, *Hoover 690,* the spikelets are much longer and contain as many as thirty flowers. The earliest vernal leaves are filiform, as much as 15 cm. long, and presumably float on the surface of the pools. The later leaves are flat, short, and broad. *O. inaequalis* is very similar to *O. californica* Vasey of Southern California and Baja California, but in that species the lemma teeth are of equal length or the central tooth slightly longer and of the same width as the lateral.

Schismus barbatus (L.) Chase. Huron (5 miles south), Fresno County, March 30, 1935, *Hoover 443.* This grass, appearing to be native, grows in sandy uncultivated places, associated with *Phacelia Fremontii* Torr., *Oenothera dentata* Cav., *Oenothera deltoides* Torr. et Frem., and *Abronia pogonantha* Heimerl. It proves to be, however, a species native to southern Europe, India, and Africa which, according to Hitchcock (Man. Grasses U. S. 276. 1935) has been introduced into southern Arizona. The species has not before been reported from California. My determination has been confirmed by Agnes Chase.

Leptochloa fascicularis (Lam.) Gray. This species, said to occur in Kern and Fresno counties, is very common at least as far north as San Joaquin County in places made wet by irrigation, especially near rice fields. Collections: Modesto (10 miles south), Oct. 20, 1934, *Hoover 70;* Oakdale, Stanislaus County, July 27, 1935, *Hoover 700.*

Paspalum dilatatum Poir. Common on the borders of rice fields, as at Escalon, San Joaquin County, June 12, 1935, *Hoover*

642. This species, a native of South America, has previously been reported from Los Angeles.

Agrostis Hendersonii Hitchc. A grass collected in a vernal pool 7 miles north of Merced, April 13, 1935, *Hoover 532a*, has been identified by Agnes Chase as this species. The only previous collection is the type: Sams Valley, near Gold Hill, Jackson County, Oregon, *Henderson 12,387*.

University of California, Berkeley,
September 30, 1935.

NEW CLOVERS FROM THE NORTHWEST

Louis F. Henderson

Trifolium idahoense sp. nov. Herba perennis, 5–8 cm. alta; folia omnia radicalia, 1–3 cm. longa, petiolis gracillimis; foliola 2–8 mm. longa obovata, rarissime obcordata, dente centrali longo, superne repando dentata; scapi gracillimi capitulis magnis comparati; flores plus minusve reflexi, vel saepe in sicco circulares; calyx glaucus, 4–5 mm. longus; dentibus glabris gracillimis, longitudine tubo aequantibus vel longioribus; flores magni purpurei, vexillo obovato apice rotundato, 12–15 mm. longo, alis parvis vexillo comparatis; legumine longo, aliquantum longo-stipitate, radix absens; caudex superne stipulis scariosis lanceolati-ovatis tectus; semina (ovula) 4 (in omnibus leguminibus visis), non 2 ut in *T. Kingii*.

Perennial, 5–8 cm. high, very glaucous and glabrous, somewhat assurgent: leaves all radical, 1–3 cm. long, with very slender petioles, leaflets 2–8 mm. long, obovate, very rarely obcordate with long, central tooth, repandly dentate above: scapes slender when compared with rather large few-flowered head; flowers two-thirds to one-half reflexed, or as often making a perfect circle when pressed; calyx glaucous, 4–5 mm. long, teeth very slender, as long as cup or slightly longer, glabrous; flowers large for size of plant, purple, banner 12–15 mm. long, obovate, top rounded, wings and keel small compared to banner: pod rather long-stipitate and long, all 4-seeded as far as seen: underground portion mainly lacking, the part collected a rootstock, its upper portion covered by the scarious lanceolate-ovate stipules: seed (ovules) 4, not 2 as in *T. Kingii*.

This is certainly near *T. Kingii*, but differs in the stem a scape, leaves smaller and never elongated, flowers less to not at all reflexed, with no extended rachis, or this when rarely formed, reduced to a short hair. The species was collected by the author in southern and southeastern Idaho, when on a col-

lecting tour for the United States Department of Agriculture in 1895. My specimens retained were all destroyed with my whole herbarium when the building in which it was housed burned many years after. The specimens now in our herbarium were left us with his herbarium by the late Mr. Leiberg, but the label attached does not tell where in Idaho I collected them: *L. F. Henderson 3962* type (Herb. Univ. Ore.). A duplicate of the same collection in the United States National Herbarium bears the following data: "Lost River Mountains, Idaho, alt. 10,200 ft., August 14, 1895, *L. F. Henderson 3962*."

TRIFOLIUM OREGANUM Howell var. **multiovulatum** var. nov. A *T. oregano* Howell differt, capitulis maioribus, 3–4 cm. latis, 2–3 cm. altis; pedicellis brevioribus, vix reflexis; floribus purpureis (?) 2 cm. longis; loba longissima calycis dentibus 2 lateralibus acutis, interdum apice propinquis itaque fere trilobatis; ovariis pilis appressis, semper (videtur) 5–7 ovulatis.

Differs from typical *Trifolium oreganum* Howell, as published in Howell's "Flora of Northwest America," page 134, in the following particulars: heads larger, 3–4 cm. wide by 2–3 cm. high; pedicels shorter, hardly at all reflexed; flowers purplish (?), 2 cm. long; leaflets pubescent on under surface, longest 1–1.5 inch long; longest lobe of the calyx with 2 lateral, long, sharp teeth, these occasionally near the tip of the tooth, thus making it almost 3-lobed; ovary appressed hairy, always, as far as seen, containing from 5 to 7 ovules.

When I first studied this plant I believed it to represent a new species, but when I compared it with Howell's description, but more with his type, which we have in our herbarium, I could only consider it a very good variety, since the two agree in shape of the flower and its parts, in aspect of the plant, in leaves, and in the main in pubescence. Howell says of his plant "ovary stipitate, glabrous, 3–4 ovuled." McDermott (N. Am. Trifoliums p. 260) describes the pod as "2-seeded." In my plant the ovary is stipitate, somewhat pubescent to hairy, and 5- to 7-seeded in the many pods I have examined. One of the three specimens on the sheet was collected for me by Mr. J. R. Patterson, June 10, 1928 (type); two by Mr. L. C. Raymond, July 11th of the same year. Both were collected near the open top of Saddle Mountain, Clatsop County, Oregon. All the above specimens are deposited in the Herbarium of the University of Oregon.

University of Oregon, Eugene,
December 8, 1935.

STUDIES IN WESTERN VIOLETS—II

Milo S. Baker

New Species and Varieties

In 1930 I spent the month of August in the Rocky Mountain National Park studying the general flora, particularly the violets. The forms of *Viola* in Colorado differ quite radically from those on the Pacific Coast. I did not find a single form that could be said to be just like the representative on our coast. Besides, Colorado has many species that are not found at all in the Pacific States, such as *V. rugulosa* Greene, *V. scopulorum* Greene, *V. biflora* L., *V. renifolia* Gray, *V. pedatifida* Don, *V. Rafinesquii* Greene, *V. canadensis* L., and *V. Nuttallii* Pursh. Many species of the western coast grow here in altered form, as *V. adunca* Sm., *V. palustris* L., *V. nephrophylla* Greene. Since few of the *Viola* species were in bloom in August, I brought back many transplants which I have since kept under observation in my garden.

In this article I wish to give the results of my study of several of these violet forms. I came in contact with three relatives or forms of *V. adunca*. One of these is *V. bellidifolia* Greene, the alpine representative of this large and varied group. It is abundant at Fall River Pass along the continental divide up to 12,000 feet and probably higher. Although it has some fairly good characters, it varies greatly and further studies may demonstrate that its proper classification is as a subspecies of *V. adunca*. At lower elevations I found two other new forms of *V. adunca* which I have described farther on in this article.

I was unable to find typical *V. palustris* L. in the regions of the Park which I explored, but instead, in habitats where one would expect to find this species, there was an abundance of a plant similar to it but with pure white, fragrant flowers and a slightly different leaf outline. Farther on in this article this plant is described as a new subspecies.

In a marsh at Moraine Park, a young girl of the neighborhood pointed out to me a violet of the acaulescent group which is closely allied to *V. nephrophylla* Greene, but which is smaller with early leaves purple tinted on the lower side and mature leaves glaucescent later in the season. All of the petals are more or less bearded, while in *V. nephrophylla* the bearding is confined to the three lower petals. Another distingushing character is the shortness of the lower petal. These characters identify it unmistakably as *V. cognata* Greene which botanists have generally regarded as synonymous with *V. nephrophylla*. Although in my opinion this violet should be relegated to a subspecies, it is as much entitled to specific rank as many of the accepted species in this *Boreali-Americanae* group. *V. cognata* is the prevalent form in Colorado, Wyoming, and Utah.

In the early summer of 1933, Alice Eastwood and John Thomas Howell collected in Pine Valley, southwestern Utah, a small-leaved, long-peduncled form, clearly of the *V. nephrophylla* group, but more slender and delicate and, strange to relate, *pubescent.* On first examination, this seemed to be a species that had escaped botanical description. Greene's account of *V. arizonica* fitted fairly well, but he goes out of his way to state that the whole plant is glabrous. However, a comparison of this sheet with Greene's type showed them to be the same species. The leaves of Greene's type specimen revealed on careful examination a slight pubescence and this made the identification certain. So far as I have been able to ascertain this is the second collection of *V. arizonica,* the first having been made at Post Spring, Fort Verdi, April, 1888. In my opinion, this violet is clearly entitled to specific rank.

1a. Viola adunca Sm. subsp. **typica** nom. nov. *V. adunca* Sm. Rees, Cyclop. 37: no. 63. 1817.

1b. Viola adunca Sm. subsp. **Ashtonae** subsp. nov. A subsp. *typica* differt planta omnino glabra, floribus pallidioribus, capsula apice valde emarginata; tuba stigmatosa a stylum perpendiculare, foramine diam. 0.3 mm.

Type: transplant from Cub Lake Trail, Estes Park, Colorado, summer, 1931; cultivated at Kenwood, California, April 8, 1933, *M. S. Baker 7348* (Univ. Calif. Herb. 540629).

Stems 10–15 cm. long, trailing or erect, widely branching, the lower portions more or less buried in the soil, springing from a strong woody tap root; herbage wholly glabrous; leaf blades ovate-cordate, conspicuously obtuse, thickish, greyish green, distinctly crenate, lower nearly as wide as long, 3 cm. wide, 3.2 cm. long (maximum length), upper leaves relatively longer, 2.5 cm. wide, 3 cm. long (maximum length); sinus of leaves shallow, 3–5 mm. deep; stipules linear with a few linear teeth, 4–5 mm. long, 1 mm. wide; lower petioles 2–6.5 cm. long, upper shorter; flowers pale blue, 1.5 cm. in diameter on slender peduncles 4.3–7.5 cm. long, ascending or prostrate, bracteate above the middle, the bractlets filiform, 2–3 mm. long; sepals oblong-ovate to oblong-lanceolate, scarious margined, acute, 4–5 mm. long, auricles small, scarcely 1 mm.; petals obovate, upper 4.5 mm. wide, 10 mm. long, lateral 4 mm. wide, 9 mm. long, bearding long and white, lower 5 mm. wide, 10 mm. long; spur slightly flattened laterally, 2.5 mm. wide, 3 mm. long; stamen-sheath as in other violets of the section *Nomimium;* spur appendages strap-shaped, approximately equal, closely appressed, 1 mm. wide, 3 mm. long; head of style barely exserted from stamen-sheath, covered above and on the sides with beards, which are about one-third the diameter of the head in length, stigmatic tube at right angles to style, foramen .3 mm. in diameter (pl. XI, fig. 4); capsule ob-

ovate, purplish, triangular in cross section, deeply notched at distal end, 5 mm. wide, 5–6 mm. long (pl. XI, fig. 7); seeds light brown, cylindrical-ovoid, 1.07 mm. wide, 2.35 mm. long, caruncle large, lateral and terminal, projecting approximately one-fifth the length of seed beyond the point.

This violet is known only from the Rocky Mountain National Park on the trail from Moraine Park to Cub Lake. It was collected near the lower end of the trail and again a few miles farther on near Cub Lake. The altitude of the first station is about 8000 feet and of the latter perhaps 8500 feet. At both stations the plants were in moist ground and in partial shade. I have had plants from both stations under observation in my garden for several years. Here they are much depressed, the stems trailing and the long peduncles nearly prostrate. The flowers, pale blue, are strikingly different in color from those of the Pacific Coast forms of *V. adunca* which are much darker. The bearding on the lateral petals of *V. adunca* subsp. *Ashtonae* shows as two white patches, the capillary hairs being white in color. The notched capsules distinguish this subspecies from other forms of *V. adunca* except subspecies *radicosa* which, although having similar notched capsules, is densely covered with a fine pubescence. Altogether this is a very distinct form which eventually may prove to be of higher rank than a subspecies. It is named in honor of Mrs. Aven Nelson (née Ruth Ashton) who assisted me materially in my study of the flora of Rocky Mountain National Park.

1c. Viola adunca Sm. subsp. **radicosa** subsp. nov. A subsp. *typica* differt foliis basi minus cordatis vel saepe solummodo truncatis, acuminis elongatioris, capsulis apice valde emarginatis; rhizoma radices plures ferens; tuba stigmatosa lata deorsum et prorsus directa, foramine magnitudine fere capitulo aequante; herba pilis brevibus retrorsis ubique dense tecta.

Type: Kawuneeche Valley, 12 miles north of Grand Lake, Colorado, August 25, 1930, *M. S. Baker 4772* (Univ. Calif. Herb. 540628).

Plants 5–12 cm. high, stems erect or ascending, much branched, the greater part often buried and bearing adventitious roots, the whole springing from a deep-seated woody tap root; herbage densely covered everywhere with a short and mostly retrorse pubescence; leaf blades 2.3–3.1 cm. wide, 2.5–3.5 cm. long, ovate with a subcordate or truncate base and often with an acuminate tip which is however conspicuously obtuse, shallowly and irregularly crenate; sinus of leaves shallow or none, never more than 2–3 mm. deep; petioles conspicuously winged, those of the lower elongated, 3–7.8 cm. long, upper much reduced; stipules inconspicuous, narrow, almost subulate, sparingly toothed and these narrow, 4–7 mm. long, .5–1 mm. wide; flowers pale blue with a

paler center about 16 mm. in diameter, on peduncles apparently shorter than the leaves, bibracteate near the flowers, the bractlets narrowly linear, 6–7 mm. long; sepals glabrous, lanceolate, scarious margined, acute, slightly auricled, distinctly nerved; petals obovate, upper 6 mm. wide, 10 mm. long, the lateral 5 mm. wide, 9 mm. long, abundantly bearded with long white hairs, the claw with a wide flange which overlaps the lower petal; lower petal, notched at distal end, 7 mm. wide, 11 mm. long; spur variable, laterally compressed, curved downward, 4–6 mm. long; anterior appendages of stamens tan colored, spur-appendages strap-shaped, closely appressed, 4 mm. long; head of style exserted 1.5 mm. from stamen-sheath, minutely bearded with short stiff beards on top and side of head, stigmatic tube short, directed forward and downward, foramen .30 mm. in diameter (pl. XI, fig. 5); capsule obovate, triangular in cross section, distinctly notched at summit, 6 mm. wide, 7 mm. long; seeds unknown.

This violet was first seen by me in Kawuneeche Valley, Colorado, growing in the protection of shrubs (mainly *Potentilla fructicosa*). A few days later it was found some twenty miles farther south on the same highway beyond Grand Lake. The leaf outline is distinctive for the *V. adunca* group, being less cordate at the base, often only truncate, and with greater elongation at the tip than is usual in *V. adunca* subsp. *typica*. The underground portion of the plant is interesting. It consists of numerous slender stems which spring from the crown of a woody taproot, several inches below the soil surface. From the lower part of these stems grow innumerable adventitious roots, thus a complicated and highly efficient absorptive system is gradually built up as the plant becomes more deeply buried.

This violet resembles *V. bellidifolia* Greene in the configuration of the style and stigma and in the complex root system. It has in common with *V. adunca* subsp. *Ashtonae* the only notched capsules known in the *V. adunca* group but differs from it in the shape of the stigma (pl. XI, figs. 4, 5) and in being extensively pubescent while subsp. *Ashtonae* is entirely glabrous.

2a. VIOLA PALUSTRIS L. subsp. **typica** nom. nov. *V. palustris* L. Sp. Pl. 934. 1753.

2b. VIOLA PALUSTRIS L. subsp. **brevipes** subsp. nov. A subsp. *typica* differt: planta minore; foliis orbiculatis; floribus candidis, petalis lateralibus omnino imberbibus.

Types: transplant from Estes Park, Colorado, August, 1930, cultivated at Kenwood, California, April, 1934, flowering specimen, *M. S. Baker 7629a* (Univ. Calif. Herb. 540626); transplants from Moraine Park, Colorado, 1930; cultivated at Kenwood, California, August, 1935, plants with stolons and mature leaves, *M. S. Baker 7692b* (Univ. Calif. Herb. 540625).

Plants 5–8 cm. high, wholly glabrous, acaulescent, the leaves, flowers, and stolons springing from a true rhizome which gives rise to numerous adventitious roots; leaf-blades orbicular-cordate with or without a short, very obtuse apical point, regularly and shallowly crenate-serrate, basal leaf-blades 3.6–4.5 cm. wide, 3.7–5 cm. long, the sinus of the larger leaves about 1 cm. deep, nearly closed; petioles of basal leaves 1.6–6 cm. long; stipules ovate, small, thin, entire except for scattered glandular teeth, those of the terminal bud 2.5 mm. wide, 5 mm. long, the others scarious and shrunken; stolons stout, short, 6–9 cm. long, with two or three foliaceous leaves, or exceedingly slender and nearly twice that length, with only scales at the internodes; petaliferous flowers few, pure white, fragrant, 1.2–1.4 cm. across, held well above the undeveloped leaves on peduncles 2.2–3.3 cm. high, bractlets near the middle of the peduncles, approximately opposite, lanceolate, 2 mm. long; sepals ovate-lanceolate, scarious margined, obtuse, slightly auriculate, lower 4 mm. long, 1.5 mm. wide; upper petals obovate with nearly round limb 4.5 mm. wide, 7 mm. long; lateral petals obovate, *beardless,* 5 mm. wide, 10 mm. long; lower petal 5 mm. wide, 6 mm. long, deeply concave; spur conical, its free tip 1.5 mm. long; spur appendages scarcely touching each other and projecting backwards but slightly; anterior appendages enclosing all but the head of style, this small, naked, with a slight rim dorsally and laterally; stigmatic tube short, directed downward and forward, foramen .16 mm. in diameter (pl. XI, fig. 6); capsule oblong-ovoid, triangular in cross section, somewhat truncate at apex, 4.5 mm. by 9 mm.; seeds nearly black with a small lateral caruncle reaching to the point of seed, 1.48 mm. long, .96 mm. wide, weighing .5 mg.

This subspecies abounds in moist rich shaded soil along streams and lakes of Colorado at elevations of 7500 to 10,000 feet. I found it throughout the region of Estes Park, at Dream Lake, Moraine Park, Bear Lake, Loch Lomond, Glacier Creek. I have seen a sheet from Tolland collected by Edmund R. Cross, and one from Gunnison County along Ohio Creek near Mt. Carbon collected by W. W. Eggleston. These two sheets are in Brainerd's Herbarium, and are labelled *V. palustris* L. At the Rocky Mountain Herbarium and in Coulter and Nelson's "Flora of the Rocky Mountains," subsp. *brevipes* is known as *V. blanda* Willd. because of the fragrant, pure white flowers and beardless petals. However, it lacks the pubescence on the leaves and the reddish color of capsules and peduncles, both characteristic of *V. blanda.* It is not a woodland plant but has the habit of *V. palustris* and more nearly the leaf form, though the leaves are less pointed; the capsules and seeds are nearly identical except for a somewhat smaller size. This plant is smaller in every way than typical *V. palustris*: in size of flowers, capsules, and seeds, and in length of petioles and peduncles; hence its name. More-

over, the petals are pure white while those of typical *V. palustris* are usually pale lavender, and even when apparently white have a faint lavender cast. Another marked variation in this subspecies is the entire lack of beards on the lateral petals, which in typical *V. palustris* are abundantly bearded.

3. **Viola simulata** sp. nov. Planta ut *V. Langsdorffii* excepta caulibus brevibus horizontalis non erectis, herba nullius succulenta, foliorum marginibus accurate crenatis (non crenati-serratis); stipulis minoribus; floribus minoribus; calcare minore; stylo nudo apice parum incrassato; tuba stigmatosa brevissima, lateraliter compressa, foramine diam. 4 mm.; semina pallida, 2.3 mm. longa, 1.4 mm. lata, pondere 2 mg. caruncula parva laterale, acumen parum excedenti; floribus cleistogamis pluribus floribus patentibus florere desistitis.

Type: near Shawnigan Lake, Vancouver Island, British Columbia, May 9, 1915, *J. H. Henry* (Calif. Acad. Sci. 48407).

Plant 7–15 cm. high, leaves and flowers arising from short horizontal stems which are the annual extensions of the slender buried branching rootstock; herbage glabrous throughout; leaf-blades cordate-ovate with or without an obtuse apical point, conspicuously crenate, 3.4–4.5 cm. wide, 3–5 cm. long, with a sinus 7–10 mm. deep; petioles 1.3–12 cm. long; stipules oblong-lanceolate, thin but foliaceous, entire except for microscopic glandular teeth, soon becoming scarious, 5–7 mm. long, about 3 mm. wide; flowers relatively large, violet with a paler center, about 2.5 cm. in diameter on peduncles 5–12 cm. long, the minute bractlets below the middle; sepals broadly ovate-lanceolate without auricles, the lateral largest, 7 mm. long, 2.8 mm. wide at base; petals broadly obovate, medium violet in color with lighter base, lateral petals with abundant capillary beards near base, upper and lateral petals about 8 mm. wide, 16 mm. long, lower 11 mm. wide at broadly emarginate tip, 18 mm. long including 2 mm. spur; stamen-sheath as in other violets of section *Nomimium;* spur appendages projecting downward and only slightly backwards into the short spur; style enlarged but slightly at end, naked, stigmatic tube extremely short, compressed laterally, foramen .4 mm. in diameter (pl. XI, fig. 2); capsule oblong-ovoid, somewhat truncate at tip, 6 mm. wide, 13 mm. long; seeds light brown, caruncle small, lateral, extending slightly beyond the point, 1.4 mm. wide, 2.3 mm. long; weight about 2 mg.; cleistogamous flowers abundant after open flowers have ceased (pl. XI, fig. 1).

For many years this violet has been confused with *V. Langsdorffii* Fisch. It was first discovered at Shawnigan Lake, Vancouver Island, by Mr. J. K. Henry and was identified by Ezra Brainerd as *V. Langsdorffii.* In Bulletin 224, Vermont Agricultural Experiment Station, one of Henry's plants from this locality

is shown in a colored plate (species no. 73). Although resembling the Langsdorff violet in a general way, it differs in many particulars. While *V. Langsdorffii* is a succulent plant, with fleshy petioles and peduncles, this species shows little or no succulence. The creeping stems are short, advancing only a centimeter or two in a season, and are never erect as in *V. Langsdorffii.* The stipules are much smaller; also the flowers, which have narrower petals and a smaller spur. The leaves are less pointed and with the margin crenate instead of crenate-serrate as in the Alaskan species. The characters enumerated above might be looked upon as variations, were not the pistils so entirely different. These are shown in figures 2 and 3 (plate XI), both enlarged ten diameters. In figure 2, three views of the pistil are shown, *a* being a front view, *b* a side view, and *c* a dorsal view. Note the massive style head and stigmatic tube or beak in *V. Langsdorffii* (pl. XI, fig. 3) while in *V. simulata* the style is scarcely expanded into a head and the stigmatic tube projects but little. *V. simulata* is also closely related to *V. palustris* L. having the same creeping rootstocks, similar leaves, and somewhat similar flowers. Fresh pistils are, however, very different, *V. palustris* having the style head expanded into a disk, while in *V. simulata* the style head is merely rounded. The most marked difference is perhaps the entire lack of stolons in *V. simulata,* while in *V. palustris* filiform stolons are abundant. *V. simulata* has been collected at Shawnigan Lake also by myself in 1924, and by Mrs. Viola Brainerd Baird in 1933. Typical material was collected by Dr. N. L. Gardner in 1895 on Camano Island, Puget Sound.

The material collected by Thomas Howell in 1887 at the mouth of the Columbia River, and the collection of A. S. Foster south of Westport, Washington, April 27, 1908, need further investigation, though both collections appear to be *V. Langsdorffii.*

Santa Rosa Junior College,
Santa Rosa, California,
November 15, 1935.

Explanation of the Figures. Plate XI

Fig. 1. *Viola simulata,* habit sketch of transplant from Shawnigan Lake, V. I., ×1.

Fig. 2. *Viola simulata,* pistil ×10: *a,* viewed from anterior end; *b,* side view; *c,* dorsal view.

Fig. 3. *Viola Langsdorffii* from Alaska, pistil ×10, side view.

Fig. 4. *Viola adunca* subsp. *Ashtonae,* pistil ×10: *a,* viewed from anterior end; *b,* side view; *c,* dorsal view.

Fig. 5. *Viola adunca* subsp. *radicosa,* pistil ×10: *a,* viewed from anterior end; *b,* side view; *c,* dorsal view.

Fig. 6. *Viola palustris* subsp. *brevipes,* pistil ×10: *a,* viewed from anterior end; *b,* side view; *c,* dorsal view.

Fig. 7. *Viola adunca* subsp. *Ashtonae,* capsule ×10, side view.

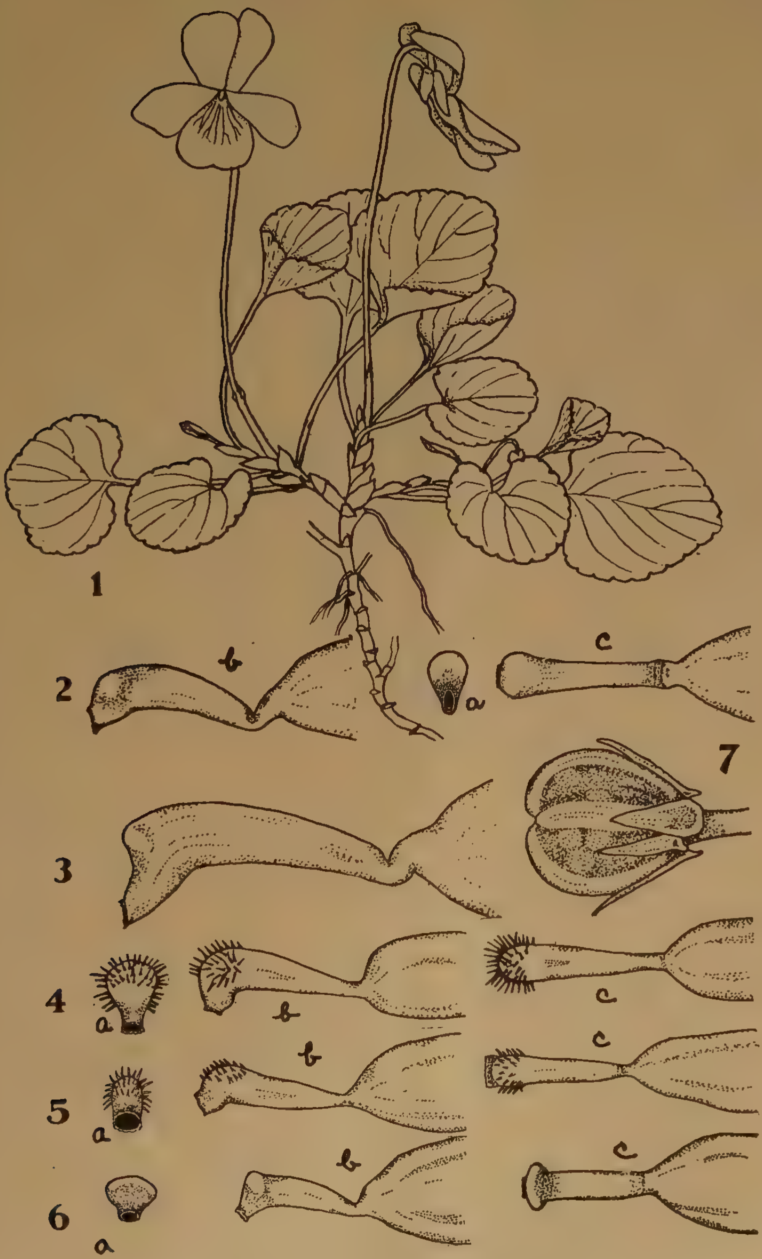

PLATE XI. STUDIES IN VIOLA.

THE GENUS SEDELLA

Helen K. Sharsmith

The genus *Sedella* of the Crassulaceae, established by Britton and Rose in 1903, has been known by only two species, both restricted to California: *Sedella pumila* (Benth.) Brit. and Rose and *Sedella Congdoni* (Eastw.) Brit. and Rose. These species were included in *Sedum* by Bentham and by Eastwood, and are so treated by Berger in his recent revision of the Crassulaceae (Die Natürlichen Pflanzenfamilien, ed. 2, 18A: 462. 1930.). Their separation from *Sedum* by Britton and Rose is on the basis of the single, erect seeds in the carpels as opposed to the many, horizontally arranged seeds in the carpels of *Sedum*. *Sedella Congdoni* has been reduced to varietal status under *S. pumila* by Jepson. In the opinion of the writer, a comparative examination of the two species substantiates the viewpoint of Eastwood and of Britton and Rose in regarding *S. Congdoni* as a specific entity. *S. pentandra,* described in this paper, adds a third species to this genus of diminutive, California annuals.

Herbarium material used in the study of this genus was obtained from the University of California Herbarium (UC), the Herbarium of the California Academy of Sciences (CA), and the Dudley Herbarium of Stanford University (SU).

Key to the Species

Stamens 5; petals erect in both flower and fruit, 2 mm. long; follicles appressed .... 1. *S. pentandra*
Stamens 10.
Petals spreading in flower, erect in fruit, 3–4 mm. long; follicles connivent .... 2. *S. pumila*
Petals spreading in both flower and fruit, 2 mm. long; follicles spreading .... 3. *S. Congdoni*

1. **Sedella pentandra** sp. nov. Herba annua, erecta, glabra, succulenta, 3–13 cm. alta; caulis rectus, simplex, vel e nodis infimis 1–3-ramosus; rami cauli principe semper breviores; cymarum rami 2–5, virgati, pseudo-paniculati, 2–3 cm. longi; flores congesti, secundi, uno- vel biseriati, 3 mm. longi, 2 mm. lati; hypanthium turbinatum; petala pallido viridi-lutea, lanceolata, 2 mm. longa per anthesin erecta, demum carpelis maturis adpressa; nectaria clavata petalorum basi leviter adhaerentia; stamina 5, corollae adnata, in sinu petalorum inserta; carpella 1 mm. longa, commisuris et suturis papillis glandulosis tectis; styli erecti, 0.3–0.4 mm. longi; folliculi conniventes papillis prominentibus, suturis acute carinatis; semen solitarium.

Erect, glabrous, succulent annual, 3–13 cm. tall, averaging 7 cm.; herbage reddish-green to green; root system small, spreading, fibrous, 0.5–2.0 cm. in diameter; hypocotyl 1–2 cm. long; cotyledons early deciduous; stem straight, usually unbranched

up to inflorescence or 1–3 virgate, delicate branches from lowermost nodes, but branches always shorter than main stem; cauline leaves sessile, entire, very fleshy, oblong-ovoid to elliptic-obovoid, obtuse, 4–5 or sometimes 7 mm. long, 3 mm. broad, point of attachment 1 mm. above gibbous base, lowest 2 leaves opposite, then several sub-opposite, all others alternate, closely imbricate in young plant (but internodes elongating with maturity to 2–7 mm.), caducous; inflorescence bracteate, a sympodium or spicate cyme, with 2–5 falsely paniculate, virgate branches 2–3 cm. long arising below the first and terminal flower, accessory cymes produced on the occasional lower branches; bracts of inflorescence like cauline leaves but progressively smaller toward branch tips, the smaller less obtuse or even acute, persistent through flowering stage; flowers crowded, secund in 1–2 rows, alternate, 3 mm. long, 2 mm. broad, sessile or subsessile; hypanthium turbinate, fleshy; sepals 5, fleshy, deltoid, 0.5 mm. long; petals coalesced at base, pale greenish-yellow, sometimes with a dorsal, longitudinal, red streak, lanceolate, 2 mm. long, inserted on hypanthium rim, alternate with sepals, erect or slightly spreading in anthesis, strictly erect and closely appressed to carpels in fruit, persistent; nectaries clavate, lightly adherent to base of petals; stamens 5, yellow, included, adnate to corolla in sinus of petals, anthers reniform, filaments capillary; carpels 5, free, green, approximate, 1 mm. long, back rounded and smooth or slightly glandular papillate, commissures and suture covered by glandular papillae; style capillary, 0.3–0.4 mm. long, erect; follicles 1.2–1.5 mm. long, 1-seeded, appressed, greenish-yellow to bright red, papillae prominent, suture sharply keeled; seeds erect, light brown, oblong-clavate, microscopically striate; 0.8 mm. long.

Type. Moss-covered sandstone boulder in partially sheltered recess on south side of stream bed, six miles (3.7 km.) above mouth of canyon, Arroyo del Puerto, Stanislaus County, Mount Hamilton Range of the South Coast Ranges, California, altitude 850 feet (261 m.), April 21, 1935, *C. W. and H. K. Sharsmith 1831* (UC 540617).

Range. Known only from the interior of the Mount Hamilton Range, 850–2000 feet, growing in rocky areas of slate, shale, or sandstone which usually dry out early; on canyon slopes, at edges of open chaparral, or near margins of small, intermittent streams.

Other collections from the type locality, showing different stages of growth. March 29, 1935, *C. W. and H. K. Sharsmith 1639,* immature plants (UC 540619); May 19, 1935, *C. W. and H. K. Sharsmith 3129,* plants in fruit (UC 540618). Additional collections. Santa Clara County: dry rocky slope at north edge of Santa Isabella Valley, altitude 2300 feet, April 28, 1935, *C. W. and H. K. Sharsmith 1848;* shale outcrop, south slope of Arroyo Bayo, altitude 2000 feet, May 5, 1935, *C. W. and H. K.*

Sharsmith 3063, May 19, 1935, *C. W. and H. K. Sharsmith 3160;* shale outcrop at edge of tributary to Sulphur Springs Creek, San Antonio Valley, altitude 2000 feet, May 9, 1935, *H. L. Mason,* June 8, 1935, *C. W. and H. K. Sharsmith 3271.* All collections mentioned above are deposited in the University of California Herbarium.

2. Sedella pumila (Benth.) Brit. and Rose, Bull. N. Y. Bot. Gard. 3: 45. 1903. *Sedum pumilum* Benth. Pl. Hartw. 310. 1849.

Erect, glabrous, succulent annual, 3–17 cm. tall, averaging 9 cm.; cotyledons ovate, sessile; main stem with several to many branches from lower nodes, branches usually stout, fastigiate to somewhat diffuse, as long as main stem; leaves sessile, entire, very fleshy, oblong-ovoid with gibbous base, obtuse, 4–7 mm. long, alternate or lower sometimes opposite, caducous; flowers crowded, sessile or subsessile, secund on the virgate branches of the bracteate, cymose inflorescence; hypanthium saucer-shaped; petals 3–4 mm. long, lanceolate, spreading in anthesis, erect in fruit, straw-colored, sometimes with faint, dorsal streak of red, lanceolate; stamens 10; carpels with a strong, fimbriate row of papillae on suture, commissures moderately papillate; style erect, 1 mm. long; follicles merely connivent, not closely approximate, 2–2.5 mm. long.

Range. Foothills of northern California, 150–2000 feet: Napa Range; western edge of Sierra Nevada from Sutter County to Merced County.

Specimens examined. Napa County: 3 miles south of Napa City, May 31, 1935, *H. L. Mason* (UC); near Yountville, May 5, 1907, *H. P. Chandler 7557* (UC, SU); Napa, April 25, 1902, *A. A. Heller* (SU); near Napa City, April 28, 1893, *W. L. Jepson* (UC); near Napa, April 25, 1902, *A. A. Heller and H. E. Brown 5360* (SU); Soda Springs, April, 1895; *C. F. Sonne* (UC). Tehama County: between Paynes Creek and Mineral on Susanville road, May 9, 1930, *Doris Gillespie 9283* (SU). Butte County: along Chico-Oroville road, 7 miles from Chico, April 19, 1926, *A. A. Heller 13923* (UC, SU), April 27, 1914, *A. A. Heller 11339* (CA, SU), *11329* (UC, SU), topotypes; Berry Canyon, May 7, 1902, *A. A. Heller and H. E. Brown 5486* (SU); foothills, March, 1897, *Mrs. C. C. Bruce 1776.* Sutter County: near Marysville Buttes, April 20, 1891, *W. L. Jepson* (UC); West Butte, Marysville Buttes, April 22, 1926, *Roxanna S. Ferris 6359* (SU). El Dorado County: between Placerville and Camino, May 25, 1907, *Katherine Brandegee* (UC). Amador County: New York Falls, 1500 feet, May 30, 1896, *George Hansen 1784* (SU). Calaveras County: 4.7 miles west of San Andreas, April 13, 1930, *John Thomas Howell 4705* (UC, CA); Table Hills near Mountain Ranch, May 18–30, 1895, *J. Burtt Davy 1609* (UC, SU); near

Jenny Lind, 1300 feet, *F. E. Blaisdell* (CA). Tuolumne County: near Sonora, May, 1925, *E. A. Green* (SU); Table Mountain above Rawhide, altitude 2000 feet, April 11–16, 1919, *Roxanna S. Ferris 1497* (UC, SU). Merced County: 7.5 miles southwest of Merced on Los Banos Road, altitude 150 feet, April 11, 1929, *John Thomas Howell 4147* (UC, CA, SU). Mariposa County: Pea Ridge road, May, 1893, *J. W. Congdon* (SU); Mormon Bar, April 27, 1889, *J. W. Congdon* (SU).

3. SEDELLA CONGDONI (Eastw.) Brit. and Rose, Bull. N. Y. Bot. Gard. 3: 45. 1903. *Sedum Congdoni* Eastw. Proc. Calif. Acad. Sci. Ser. 3, 1: 135–136, pl. XI, figs. 6a–6b. 1898. *Sedella pumilum* var. *congdonii* Jepson, Man. Fl. Pl. Calif. 450. 1925.

Glabrous, succulent, annual 3–9 cm. tall, averaging 5 cm., diffuse and usually wider than tall; cotyledons obovate, sub-petiolate; lateral branches many, delicate, tortuous, longer than the main stem; leaves sessile, entire, very fleshy, oblong-ovoid with gibbous base, obtuse, 3–5 mm. long, alternate or lowermost sometimes opposite, caducous; flowers scattered along tortuous, lax branches of the bracteate, cymose inflorescence, not obviously secund, sub-sessile; hypanthium saucer-shaped; petals 2 mm. long, radiately spreading in both flower and fruit, bright yellow with dorsal streak of red, ovate-lanceolate; stamens 10; carpels with papillae in well-developed row on suture, commissures and back moderately papillate; style recurved, 0.5 mm. long; follicles widely divergent, 1.2–1.5 mm. long.

Range. Foothills of western edge of Sierra Nevada from El Dorado County to Tulare County, California.

Specimens examined. Mariposa County: Grant's Springs, April 9, 1898, *J. W. Congdon* (type CA, cotype SU); Pea Ridge region, April 19, 1901, *J. W. Congdon* (SU). El Dorado County: Coloma, March 26, 1927, *Alice Eastwood 14170* (CA). Amador County: Ione, 300 feet, May 12, 1896, *George Hansen 1566* (SU). Madera County: Raymond, May 9, 1925, *Alice Eastwood 12587* (CA). Fresno County: Big Sandy Creek, May, 1916, *Julia McDonald* (CA). Tulare County: Porterville, April 12, 1922, *Junea Kelley* (CA), March 29, 1935, *W. B. Richardson 95* (UC), May 13, 1935, *W. B. Richardson* (UC).

Discussion

The outstanding character in *Sedella pentandra* is the presence of only five stamens, rather than ten as in *S. pumila* and *S. Congdoni*. The whorl of stamens opposite the petals is absent in *S. pentandra*. Such a fundamental and constant difference in floral pattern between *S. pentandra* and the other two species might suggest, to the non-conservative, a basis for generic distinction, since stamen number is considered to be a generic character in the Crassulaceae. Despite this and other points of distinction, there are so many characters common to the three species that

any such view-point is precluded. It seems apparent that there is close genetic relationship within the group. The complete loss of one whorl of stamens is only one change, coincident with other changes, which has led to speciation within the group.

In habit *S. Congdoni* is comparatively distinct from the other two species, though there is considerable similarity of form among all three, and depauperate or merely small plants are very like in appearance. In typical plants, however, a tortuous, diffuse, wider-than-tall aspect definitely marks *S. Congdoni,* while *S. pumila* and *S. pentandra* share a fastigiate, virgately branching habit. These latter two species are usually easily distinguished, however, by size and branching, *S. pumila* being larger, more robust, and with the several to numerous lateral branches as long as the main stem, giving the plant a flat-topped aspect; in *S. pentandra* the lateral branches are either lacking or are definitely shorter than and subordinate to the main stem. There is often a suffusion of red in the stem and leaves of all three species, but in the material available for study this tendency is least evident in *S. pumila,* and most evident in *S. Congdoni.* Plants of *S. Congdoni* may have the chlorophyll almost completely obscured by red coloration. In the case of *S. pentandra,* field observations indicate this redness of herbage to be highly variable and probably correlated with the continued availability of water. Plants growing in soil which continues moist are almost pure green at anthesis; plants growing in soil which dries out early are the reddest. Further field observation of *S. pumila* and *S. Congdoni* might reveal similar variability in coloration. Seedlings of the three species, now being grown together under uniform habitat conditions, show, however, that *S. Congdoni* assumes this red coloration early in the germination process, in marked contrast to *S. pumila* and *S. pentandra.*

The inflorescence is in each case a sympodium or spicate cyme, that is, of the determinate nature so common in the Crassulaceae, with branches produced below the first and terminal flower in simulation of a racemose or indeterminate condition. The bracts do not subtend the flowers as in a true raceme, but are on the opposite side of the branch. Displacement often brings the bracts and flowers into close juxtaposition, however, and this increases the racemose aspect of the inflorescence. In both *S. pumila* and *S. pentandra,* the flowers are crowded on these falsely racemose branches, and come into bloom gradually from base to tip of the branches; in *S. Congdoni* they are more distant, and there is a tendency for flowering to occur nearly simultaneously all along the branches. These latter two characteristics, combined with the tortuous, diffuse nature of even the ultimate branches, make *S. Congdoni* distinct in inflorescence from *S. pumila* and *S. pentandra.*

The flowers are closely similar in the three species, but the petals of *S. pumila* and *S. pentandra* are erect, while those of *S. Congdoni* are radiate; the petals of *S. pumila* are one and one-half to two times longer than those of *S. Congdoni* and *S. pentandra*. These two characteristics and that of petal color (straw-yellow in *S. pumila,* bright yellow in *S. Congdoni,* greenish-yellow in *S. pentandra*) are the most obvious floral distinctions. The most fundamental, that of stamen number, has been discussed.

The petals of *S. pumila* are described as narrow by Bentham, as linear-lanceolate by Eastwood, and as linear by Britton and Rose. In the latter treatment the "linear" petals of *S. pumila* are used as the key character to distinguish the species from *S. Congdoni.* The writer is unable to find sufficient difference in shape of petals among these three species to warrant use of petal shape as a key character.

Fig. 1. Distribution of the genus *Sedella.*

Nectaries, or so-called receptacle scales, one at the outer base of each carpel, are commonly present in the Crassulaceae, and are to be found in the three *Sedella* species, notwithstanding the statement by Britton and Rose of "scales none" for *S. pumila.* In *Sedella* these scales are lightly adherent to the base of the corolla opposite the petals, and detach with the corolla when it is removed. Such a position suggests that the scales are staminodia, rather than outgrowths of the receptacle.

The carpels are very similar in the three species, although they can be distinguished accurately by the character of the style; in *S. pumila* the style is long (1 mm.) and erect, in *S. Congdoni* it is half as long (0.5 mm.) and recurved, in *S. pentandra* it it still shorter (0.3–0.4 mm.) and erect. As to glandular papilla-

tion of the carpels, there seems to be considerable variation within each species, but *S. pentandra* shows the greatest degree of glandulosity, and *S. pumila* shows the greatest development of the papillae along the suture, where they form an obvious fringe.

Early in the germination of *Sedella* seedlings it is possible to distinguish the three species. The first evidence of differentiation appears in the cotyledons and early leaves. Those of *S. pentandra* are sessile and ovoid to almost spherical, those of *S. Congdoni* are sub-petiolate and obovate, and those of *S. pumila* are sessile and ovate. From early germination on, *S. pentandra* seedlings are the smallest, *S. pumila* seedlings the largest; this size difference continues as the plants mature. The striking red coloration which appears in young seedlings of *S. Congdoni* has been mentioned. Another distinguishing character of the adult plant which evidences itself soon after germination is that of branching. *S. Congdoni* and *S. pumila* seedlings show development of lateral branches three weeks after planting. These branches arise from the axils of the lowest pair or two of leaves. and often from the cotyledonary nodes as well. At five weeks of age they are well-developed in *S. Congdoni* and *S. pumila,* but there is no trace of lateral branches in *S. pentandra* at this stage.

In habitat requirements the three species of *Sedella* are comparatively similar. All grow in the foothills or adjacent plains, in rocky places which are relatively wet in spring and very hot and usually very dry by middle summer. *S. pumila* is extreme in this regard, often growing in rocky depressions which form rain-pools in the early spring and are exceedingly dry by summer.

The genus is found only in the northern and central portion of California, restricted to the interior and eastern edges of the Coast Ranges and the western edge of the Sierra Nevada. There is little overlapping of geographic range between the species. *S. pentandra,* as now known, is the most highly restricted, and is limited to the interior and eastern side of the Mt. Hamilton Range in Santa Clara and Stanislaus counties. *S. pumila* has the widest range. It is most common in northern California, where it is known from Napa County in the North Coast Ranges, from Sutter and Butte counties in the northern Sacramento Valley, from Calaveras, El Dorado, and Tuolume counties in the Sierra Nevada foothills, and from Merced County (a single locality) in

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EXPLANATION OF THE FIGURES. PLATE XII.

Fig. 1. *Sedella pentandra,* habit $\times 0.7$.
Fig. 2. *Sedella pumila,* habit $\times 0.7$.
Fig. 3. *Sedella Congdoni,* habit $\times 0.7$.
Fig. 4. *Sedella pentandra,* single flower $\times 12$.
Fig. 5. *Sedella pentandra,* follicle $\times 21$.
Fig. 6. *Sedella pumila,* follicle $\times 21$.
Fig. 7. *Sedella Congdoni,* follicle $\times 21$.

PLATE XII. THE GENUS SEDELLA.

the San Joaquin Valley. *S. Congdoni* is known from the foothills of Mariposa, Madera, Fresno, and Tulare counties, on the eastern side of the San Joaquin Valley, and from El Dorado County (a single locality) and Amador County (a single locality) on the eastern side of the Sacramento Valley.

University of California,
Berkeley, October, 1935.

STUDIES IN PENSTEMON—III

David D. Keck

The Section Cryptostemon

A new section is required to include the recently detected species described below. No close affinities are obvious, but there is an apparent relationship between this and the section *Erianthera* Bentham. The name *Cryptostemon* calls attention to the fact that the stamens are not only included within the throat, but are hidden by the closing of the orifice of the corolla, and that the staminode is of a brevity unexcelled within the genus.

CRYPTOSTEMON Keck sect. nov.

1. PENSTEMON PERSONATUS Keck sp. nov.

Herba perennis 3–5.5 dm. alta; radicibus fibrosis numerosis; caulibus paucis erectis virgatis minute puberulis; foliis subremotis integris vel obscure obsoleteque denticulatis plus minusve glaucescentibus supra glabriusculis viridibus subtus puberulis pallidioribus ovatis vel ovato-oblongis pleraque obtusis 3–6.5 cm. longis 1.2–3.5 cm. latis, inferioribus breviter petiolatis, superioribus sessilibus, floralibus ad acuminatas bracteas vix 1 cm. longas abrupte reductis; panicula laxa 7–25 cm. longa glanduloso-pubescenti, pedunculis tenuibus divergentibus infimis ad 8 cm. longis 2–5-floris, pedicellis multum brevioribus, floribus suberectis; calyce 5–6 mm. longo, lobis ovato-lanceolatis abrupte longe acuminatis anguste scariosis; corolla personata coeruleo-violacea (?) 20–25 mm. longa extus glabra vel parce viscidula intus dense barbata, tubo superne vix dilatato apud apicem plus minusve constricto, limbo brevi, labio superiore 3.5 mm. longo, labio inferiore 5 mm. longo, lobis a marginibus revolutibus; staminibus fertilibus inclusis glaberrimis, loculis antherarum divaricatibus subexplanatibus 1.2–1.4 mm. longis, staminodio sigmoideo vix 4 mm. longo praesertim apice superne dense flavo-barbato; capsula *ca.* 6 mm. longa, ovoidea; seminibus ignotis.

Type: *John B. Leiberg 5087,* collected July 10, 1900, on a dry hillside in Flea Valley, Butte County, California, at 4500 feet (1370 meters) elevation, deposited in the United States National Herbarium, No. 610331. Another collection of this species was also made in Butte County, in dry soil near Bald Hill, elevation

6000 feet, July 8, 1900, *Leiberg 5064* (US). Aside from these two collections made on a single trip, the species apparently remained uncollected until July, 1934, when it was again taken, this time by G. T. Nordstrom, No. 196, three-fourths of a mile southwest of Mt. Ararat, Plumas County, California, at 5500 feet elevation. This sheet is in the Vegetation Type Map Herbarium of the United States Forest Service, on deposit at the Herbarium of the University of California. The three localities may be found on the Bidwell Bar Quadrangle, United States Geological Survey map, forming a right triangle, the hypotenuse of which is some twenty miles across.

The writer, in company with J. Clausen, visited Flea Valley early in July, 1935, hoping to recollect the species. In spite of the fact that the season was favorable, no results rewarded a careful search of the vicinity. Since the species occurs in one of the more thoroughly botanized areas of the state, it appears to be not only one of the more interesting, but also one of the rarest species in the genus.

In floral morphology, there is a similarity between *P. personatus* and *P. hirsutus* (L.) Willd. of northeastern United States, the corollas of both being notable for having the lower lip pressed against the upper so as to close the orifice to the throat. In a flower of this type, pollination is effected only by bees of sufficient weight to depress the lower lip. The throat in *P. personatus* is bearded on all sides within the orifice, not only heavily so along the elevated ridges of the lower lip, but fairly heavily in corresponding positions on the roof.

The nearest affinity of *P. personatus* appears to be in the section *Erianthera*, possibly with such a species as *P. nemorosus* (Dougl.) Trautv. of the Cascade Range, which occurs from British Columbia to Siskiyou County, California. Vegetatively the two are rather comparable, *P. nemorosus* differing chiefly in its larger size, sharply serrate leaves and more compact inflorescence. The similarities do not end here: both have a remarkably short posterior lip of the corolla well exceeded by the anterior one and a short staminode. In the former feature, *P. nemorosus* deviates from the usual type found within its section, but as to the staminode, certain other species of the *Erianthera*, such as *P. rupicola* (Piper) Howell, possess an even shorter one and in this respect compare more approximately with *P. personatus*. No other section of the genus has staminodes so short as those in *Cryptostemon* and some members of *Erianthera*. As to the pubescence within the throat, *P. nemorosus* has none and therefore is not comparable in this respect with *P. personatus;* but *P. fruticosus* (Pursh) Greene, *P. Menziesii* Hook., and related species in that portion of the *Erianthera* have a large amount of pubescense on the ridges in the floor of the throat as well as along the lower walls. Thus, with the exception of woolly anthers, *P. personatus*

matches features from many species of *Erianthera* and serves as a link to connect that salient section with *Eupenstemon.*

Note on Section Saccanthera

Penstemon serrulatus Menz. ex Smith, in Rees' Cycl. 26: Pentstemon, sp. 5, 1813. Since publishing on the section *Saccanthera,*[1] it has been brought to the author's attention by F. W. Pennell that this earlier name must replace *P. diffusus* Dougl. ex Lindl. (1828) for the well known species that occurs chiefly to the west of the Cascadean crest from British Columbia to Oregon. The type of *P. serrulatus* has not been seen by the writer, but is probably preserved in the British Museum. A specimen which is doubtless an isotype, however, in Herbarium Hookerianum, Kew, plainly establishes the identity of the species. The latter specimen is labelled in Hooker's hand "Penstemon serrulatus" and, on succeeding lines, "Menz." and "A. M."

Carnegie Institution of Washington,
Stanford University, California,
January 14, 1936.

SURFACE PLANKTON DIATOMS IN THE NORTH PACIFIC OCEAN IN 1934

W. E. Allen

In connection with general plans of the United States Navy to become better informed concerning a number of conditions in the North Pacific Ocean, the United States Steamship Bushnell made a cruise in the summer of 1934 around the Gulf of Alaska and southward from the Aleutian Islands to the Hawaiian Islands. On this cruise Mr. R. R. Revelle of the Scripps Institution of Oceanography served as a special investigator giving particular attention to collecting water samples and hydrographic data. In addition he collected 141 surface catches of phytoplankton (mostly diatoms), using the standard Scripps Institution method of filtering a measured amount of water through number 25 bolting silk. The amount filtered at each catch on this cruise was twelve liters. I have completed the examination of this material, but it is not probable that a report covering full detail can be prepared soon, although Mr. Revelle has his own report far advanced. For that reason I am writing this note for the benefit of readers interested in the more general features.

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[1] Univ. Calif. Publ. Bot. 16: 367–426. 1932.

Catches were begun north of Vancouver Island in the general region where a great abundance of diatoms was found in 1923 (Bull. Scripps Inst. Oceanog. Tech. Ser., 1: 39–48) and a moderate abundance in 1924 (ibid. 2: 139–153). Although the catches of both of those series were made more than two months earlier in the seasons, the 1934 series resembled them in showing a considerable abundance, especially near the southern and eastern shores of Calvert Island, where numbers of more than 2,000,000 cells per liter were reached. This similarity appeared to hold also in the vicinity of Princess Royal Island where small catches in the more southerly part were succeeded by a large one at the north end. The largest catch in the 1934 series was made almost west of Point Baker (north end of Prince of Wales Island) in Sumner Strait, a condition apparently different from the other series when at the earlier period only small catches were taken in Sumner Strait. But, in the main, the catches in Alexander Archipelago in 1934 in July tended to show large and small catches according to locality much like those in April of the earlier series. Such conditions suggest that the productive period may extend over a fairly long time where the locality is favorable, and that certain localities may be favorable or unfavorable year after year because of characteristics peculiar to their geographic or topographic position.

Skirting the northern border of the Gulf of Alaska in August, no large catches were found, but two of moderate size (over 100,000 cells per liter) were taken near Kenai Peninsula. This showing seems to be in direct contrast to that of 1923 when fourteen catches of sizes comparable to this were found around the northern border of the Gulf. However, the contrast may be only apparent because, in addition to the time difference, there was a difference in distance from shore over most of that part of the cruises. In 1934 the Bushnell remained much farther from shore until nearing the Kenai Peninsula than did the United States Coast and Geodetic Survey Ship Pioneer in 1933. So far, the Scripps Institution has never received any large catch from far offshore in the Gulf of Alaska, although a considerable number of catches have been obtained in four different series.

Near the Alaska Peninsula and the Aleutian Islands the agreement with the results of former series was fairly good, no large catches being obtained, and very few showing an abundance greater than some thousands of cells per liter.

From the western section of the Aleutian Islands, on the run southward to Honolulu, the sampling was entirely new so far as is known at the Scripps Institution. Catches in that part of the cruise were made mostly between meridians 174 and 158 West. Out of the ninety catches taken on the southward run

about half yielded one or more specimens of at least one species of diatoms in the fraction of the catch examined. In the open ocean at points about three hundred miles south from the nearest land (some of the smaller islands of the Aleutian chain) catches were obtained showing three or more species of diatoms, one with eight species yielding more than 2000 cells per liter. Seven of these species are often seen along the California coast, but *Coscinodiscus marginatus* Ehr., which was represented in every catch for about three hundred miles, is rather rare in California waters.

The largest catches obtained in mid Pacific were between latitudes 40° N. and 43° N., one reaching the really striking total of 220,000 cells per liter. The position of this was latitude 42° 23′ N., longitude 169° 47′ W. The species *Chaetoceros neapolitanus* Schroed. was mainly responsible for such abundance, but the numbers of the unicellular *Chaetoceros peruvianus* Btw. were notably large (more than 40,000 cells per liter). These relatively large catches in mid ocean were taken late in August at a time when abundance of plankton diatoms is always very low near La Jolla. However, both species are likely to be found in considerable numbers offshore and below the surface level in the La Jolla region. The abundance of both species in this particular locality may have been due partly to their oceanic habit as well as to certain hydrographic and meteorologic conditions peculiar to mid ocean.

I suppose that it is easy to see that the greatest importance of this pioneer series in investigation of phytoplankton in mid ocean in the North Pacific lies in the fact that it has shown that diatoms may occur at the surface in notable numbers and in the resultant suggestion that there is a mid ocean flora to be investigated. With such abundance at the surface, it is reasonable to suppose that there may be larger or smaller numbers at lower levels, just as has been found to be true in localities nearer to shore. In addition, the records of occurrence of several species in a totally new locality have a definite interest, aside from the possibility that renewals of populations on the California coast may be more or less related to mid ocean occurrences or productiveness.

Scripps Institution of Oceanography,
University of California,
La Jolla, California, December 15, 1935.

REVIEW

The Scrophulariaceae of Eastern Temperate North America. By Francis W. Pennell. Monographs of the Academy of Natural Sciences of Philadelphia, Number 1. Pp. xiv + 650, with 43 figures and 155 distributional maps. Philadelphia, November, 1935. $5.00.

The present volume may be generally acclaimed as the most important contribution that has appeared on the Scrophulariaceae since the researches of George Bentham culminated in his classical treatment of the family in De Candolle's "Prodromus" in 1846. One realizes upon studying the present paper that Pennell not only possesses an intimate knowledge of the Scrophulariaceae, but he uses that knowledge most logically in arriving at sound phylogenetic conclusions. His handling of the various units displays a complete familiarity with their characteristics and a keen intuition for their past history.

This work is intended to include every species of Scrophulariaceae growing between the Laurentian Divide and the Gulf of Mexico, and between the Atlantic Ocean and the eastern base of the Rocky Mountains, an area sufficiently vast to number among its 51 genera and 218 included species representatives of about 75 per cent of the generally accepted tribes that compose the family. On the basis of their study, Pennell draws up a new phylogenetic classification for the Scrophulariaceae as represented in this area.

The masterly work of Bentham has tempted little criticism in the 90 years subsequent to its appearance, and later accounts have left it fundamentally unchanged. Still, it dates from pre-Darwinian times and takes no account of the evolutionary development of the group. Pennell attempts a reclassification from the phylogenetic viewpoint for which there is ample material in the great diversity of floral structure in the family. The resulting rearrangement is a stimulating endeavor that makes one regret the whole family could not have been so treated. Many innovations will be found, and it appears to the reviewer that doubtless the majority of these should be universally acceptable. Only a few points can be mentioned. His first distinction in formulating a new classification within the family is between the subfamilies Antirrhinoideae and Rhinanthoideae, which may be distinguished by the relative positions of the corolla-lobes. In seeking the most primitive tribe within the first subfamily, Pennell disputes the long held hypothesis that *Verbascum* represents the logical connecting link between Scrophulariaceae and the actinomorphic family Solanaceae; and because he believes *Verbascum*, with its five stamens and only slightly zygomorphic corolla, has been derived from a bilabiate type with didynamous stamens, he transfers the tribe Verbasceae to a more advanced position. Instead, a tribe with usually open-throated zygo-

morphic corolla and didynamous stamens, the Gratioleae, is accorded the primitive position, of which, on this coast, *Mimulus* is the most common example. At the apex of evolution for the second subfamily, Rhinanthoideae, Pennell follows Bentham in placing the tribe Euphrasieae. Within that tribe, however, *Orthocarpus* and *Castilleja* are advanced to final positions ahead of *Pedicularis* and *Melampyrum,* a position the relative complexities of their calyx and corolla would seem to warrant. Two western genera, *Collinsia* and *Tonella,* constitute a new tribe, Collinsieae, carved from the Cheloneae as circumscribed by Bentham. The tribe Digitaleae has had all but two genera removed from it to form the Veroniceae.

Throughout this study especial importance has been attached to the effect of floral structure on pollination or vice versa, and the evolutionary value of diverse methods of pollination.

One finds in the introduction an important discussion of species- and genus-concept in addition to detailed information on taxonomic methods, distribution and phylogeny.

The body of the paper consists of the systematic account. Analytical keys are sufficiently detailed to cover the lack of specific descriptions, only the new units being described in full. Color notes have been given quite fully in the discussion accompanying each species. Pennell is a master at elucidating the nomenclatural tangles that accompany abundant synonymy, and this reviewer is pleased that such an important phase of descriptive botany has received detailed attention. At times the author prefers to set his own standard above the International Rules, a practice that will be frowned upon by those who feel conformity leading to uniformity is a greater desideratum at present than innovations seeming to have greater logic in their favor. His subspecies are written as trinomials, a practice that invites misinterpretation. But Pennell gives in full a reason for each change, so one finds it easy to evaluate the merits of his work. "The synonymy is restricted to original descriptions and combinations appearing in recent literature, thus failing to record many other combinations deemed not essential to present nomenclature." This omission is unfortunate in a work otherwise so complete. The reviewer finds some 23 synonyms omitted from the account of *Penstemon,* for example.

Practically every species that occurs within the area has an accompanying distributional map. This most important feature shows at a glance where the species occurs, whether its distribution is the expected or erratic, and, on many maps, how the distribution of the species coincides with such geologic features as the limits of Pleistocene glaciation. Each native species within the area of the paper is considered over its entire range in temperate North America. Accordingly, many Pacific Coast species are mapped and cited in full. The citation of specimens

is vast, some 25,000 herbarium specimens of the 40,000 examined being listed! The collections in 88 herbaria were studied, a thoroughness unduplicated in American botany.

Pacific Coast botanists will find changes in the names or status of some of their species of *Gratiola, Lindernia* (*Ilysanthes*), *Scrophularia, Linaria,* and *Veronica.*

A valuable third portion of the volume concerns the distribution of the flora of eastern North America, as illustrated by the Scrophulariaceae. The geographical and geological factors are considered in view of the information given in the detailed maps of distribution, and much original data of import to plant geographers is presented.

Dr. J. H. Barnhart aided Dr. Pennell in compiling the included list of over 1,000 complete names of persons whose collections within the area have been of most importance, with data as to their years of life, the states where they have been most active, and the depositories in which their material is best represented.

All students of systematic botany will find this a model of excellence for style and attention to detail, and specialists may to advantage gain a fresh understanding of this important family from a perusal of its pages.—David D. Keck.

NOTES AND NEWS

While on a field trip in the vicinity of Piñon (Vallecito) Mountain in eastern San Diego County, January 1–3, 1936, a group from the Department of Biology of San Diego State College noted the occurrence of *Calliandra eriophylla* Benth., a plant which previously has been recorded from only one locality in California: near Ogilby, eastern Imperial County. The colony, discovered by Miss Florence Youngberg as the party was descending Piñon Mountain, is on the south side of the mountain, about one-half mile from the camp at the cave in Upper Blair Valley. It was estimated that the colony covers an area of about fifty acres with one plant to about every two hundred square feet. On the dry slope most of the plants were about one foot in height, while those in the wash were up to two feet in height and were in leaf, flower, and fruit. Other plants found in the same region were *Bernardia myricaefolia, Thamnosma montana,* and *Acacia Greggii.*

Dr. Jens Clausen, Carnegie Institution of Washington at Stanford University, has been elected Honorary Fellow by the Botanical Society of Edinburgh.

Due to the long delay in the appearance of the revised edition of Piper and Beattie, "Flora of Southeastern Washington and Adjacent Idaho," the original 1914 edition has been

reprinted—"litho printed." The book is available at the Associated Students' Book Store, Pullman, Washington, for $2.00, plus postage.—Lincoln Constance.

The Wild Flower Show of the Santa Rosa Junior College will be held Sunday, May 3, 1936, in the Science Building of the College. The exhibit will open at 1:00 P. M. Due to careful planning by Prof. M. S. Baker and the assistance of a large number of interested contributors, the flora of the region will be well represented. The Santa Rosa Junior College Wild Flower Exhibit has long been known to botanists as one of the most outstanding exhibits in the state.

PROCEEDINGS OF THE CALIFORNIA BOTANICAL SOCIETY

Thursday, December 12, 1935. A meeting was held at 8:00 P. M., 2093 Life Sciences Building, University of California, Berkeley, California. Dr. George J. Peirce, President, occupied the chair. The report of the nominating committee was read by Professor H. E. McMinn. The following officers were nominated: President, Dr. George J. Peirce, Stanford University; First Vice-President, Miss Alice Eastwood, California Academy of Sciences, San Francisco; Second Vice-President, Professor Emanuel Fritz, University of California, Berkeley; Treasurer, Dr. David D. Keck, Carnegie Institution of Washington, Stanford University; Secretary, Miss Ethel Crum, 4004 Life Sciences Building, University of California, Berkeley. There were no nominations from the floor. Following the business meeting, Mr. J. T. Howell, California Academy of Sciences, Golden Gate Park, San Francisco, gave a lecture on "The Sixth International Botanical Congress: some enactments in nomenclature and their bearing on certain problems in western American phanerogams." Mr. Howell reviewed three important nomenclatorial problems which were acted upon by the Congress: the proposal for the conservation of a limited number of specific names which was defeated by a vote of 208 to 61; the decision, approved by a vote of 217 to 40, that a botanist proposing a new combination in specific or subspecific categories is to be credited as author of the new combination even if he misapplies or misidentifies the new name he has just made; and, the agreement, 182 to 63, that a new article be added to the International Rules declaring names illegitimate that are published as "eventual" or "provisional" names. Dr. L. R. Blinks, Stanford University, then reviewed the program of the section on Plant Physiology at the Congress.—E. Crum, Secretary.

THE TRANSITION FROM DESERT TO CHAPARRAL IN BAJA CALIFORNIA

Forrest Shreve

The desert region of western North America is almost completely surrounded by areas with higher rainfall and with vegetation of greater water requirement. Only on the coasts of Sonora and Baja California does it reach the edge of the continent. Around its periphery the vegetation of the desert merges either abruptly or gradually into that of the adjacent regions. Owing to the position and extent of the desert it borders on dissimilar types of vegetation on the east and west and at different latitudes. There are therefore a number of distinct types of transition, leading respectively to coniferous forest, coniferous woodland, evergreen oak forest, subtropical thorn-forest, chaparral and grassland. The aim of this paper is to describe some of the features of the transition region between desert and chaparral which lies along the northwestern coast of the Mexican territory of Baja California.

In northern Baja California the Juarez and San Pedro Martir mountains form an effective barrier between the desert which occupies the narrow lowland along the Gulf of California and the chaparral and transition which occupy the Pacific coast. The mountain barrier extends for 160 miles south of the International Boundary. Along the Gulf the desert shows little change through this distance, but on the Pacific slopes the two and a half degrees of latitude comprise large areas of true chaparral in the north, and all stages of the transition up to the final disappearance of the vegetational features of the chaparral and of nearly all its characteristic species. South of the southern end of the San Pedro Martir Range, desert extends from the Gulf to the Pacific. On the latter coast the northern limit of desert away from the littoral may be placed about twenty miles north of Rosario at latitude 30° 15′ N. The southern limit of chaparral below an altitude of five hundred feet is in the Santo Tomas Valley, about one hundred miles north of the limit of the desert.

At a number of localities in southern California the vegetation of the Colorado Desert merges into chaparral within distances of twenty miles or less. These cases of great change in a short distance are found on the slopes of the San Jacinto Mountains and along the crest of the Cuyamaca Mountains. They are the product of a rugged topography and of the sharp climatic change which it produces. On the coast of Baja California the climatic basis for the transition lies partly in the normal latitudinal change in temperature conditions, but chiefly in the

Madroño, vol. 3, pp. 257–320, July 1, 1936.

gradual waxing of the influence which the mountain background exerts on the rainfall on passing north from the edge of the desert.

There are three criteria which serve to distinguish the plant communities of the desert from other types of vegetation: (a) the low stature of the plants, (b) the wide spacing of the plants, and (c) the intermingling of dominant plants of dissimilar forms and types. The stature of desert vegetation may vary from a few inches to fifteen feet. Isolated individuals may reach a height of forty to fifty feet but such plants are widely spaced. The spacing may vary from a few plants per acre to a number which covers eighty per cent of the surface, but the thickest stands usually have a very low stature. The mingling of dissimilar types is greatest in the warmer deserts of the world and in the most favorable desert habitats. In Baja California it is well marked in all but the most unfavorable habitats, in which one or two forms may compose the vegetation. Where such simplicity is found the stature is low and usually the spacing is wide.

The most extended study of chaparral has been made by Cooper,[1] who defines it as "a scrub community, dominated by many species belonging to genera unrelated taxonomically, but of a single constant ecological type, the most important features of which are the root system, extensive in proportion to the size of the plant, the dense rigid branching, and preeminently the leaf, which is small, thick, heavily cutinized, and evergreen." The stature of chaparral frequently varies without great change in its composition. Its height is commonly greater than that of desert shrubbery, but it becomes greatly reduced in dry situations. The density is invariably greater than that of all but the most exceptional stands of desert shrubbery. The average leaf size is greater in chaparral than in desert. In its typical development chaparral is so dense as to form an unbroken cover and to present a canopy of uniform height except where local conditions permit the occurrence of widely spaced broad-sclerophyll trees.

On the western slopes of the Cuyamaca Mountains, in San Diego County, California, the chaparral shows a greater variability of composition and a greater irregularity in height and density than it does from Monterey County to Ventura County. South of the International Boundary there are some stands of chaparral which exhibit great uniformity and make the hills appear as if draped in immense pieces of green velvet. In general, however, the chaparral south of the Boundary shows an increasing tendency toward diversification and openness. Conditions in California indicate that the bodies of chaparral which

[1] Cooper, W. S. The broad-sclerophyll vegetation of California. Carnegie Inst. Wash. Pub. No. 319. 1922.

are most uniform in height, spacing, and composition are the ones found on the most uniform substratum. Even as far north as San Luis Obispo County there are localities in which the slopes are of such great irregularity in pitch, topography, depth of soil, and character of underlying rock that their plant cover is highly diverse. In Baja California a similar diversification may be noted on relatively uniform substrata in the region immediately south of Todos Santos. South of San Vicente there is a steadily increasing diversification in height and spacing, accompanied by the appearance for the first time of a strong intermixture of plants which are not of the chaparral type. At high elevations on the west face of the San Pedro Martir Range there is much true chaparral, but the writer has not visited that region.

As is true of the meeting ground between any two great plant formations, the dominant plants of each formation are found to vary in the distance to which they extend into the other. This indicates that their habitat requirements are not so nearly identical as their close association in the midst of their respective formations would suggest. Also, in all transition regions there are frequent reversals in the progressive change, due to the existence of small areas in which the conditions are unlike those prevailing around them. The trend of change in the vegetation between Rosario and the Boundary is away from the characterisitics of the desert and toward those of chaparral. Indeed, the vegetational features of the desert extend farther north than do its characteristic species. This is particularly true with respect to the concurrence of dissimilar types, as many shrubs and bushes which are not of the broad-sclerophyll type are dominants and subdominants in the transition as far north as Ensenada.

The extreme penetration of the chaparral region by desert types is found in the occurrence of *Yucca, Ephedra* and four types of cacti north of the International Boundary. With one exception these are represented by species which do not range north from the desert, although their derivation from desert forms is strongly indicated.

The principal features of the transition that may be observed in going north along the Pacific slopes of Baja California are the following: (1) there is a progressive increase in the density of the vegetation. In the vicinity of Rosario there are few situations in which shrubbery forms a close stand, in strong contrast to the compact chaparral of north slopes in the Santo Tomas Valley. (2) There is an increasing uniformity in the height of the dominant plants. In the open vegetation of the desert the lack of uniformity in height is not likely to be noted, but it becomes conspicuous in some of the stages of the transition in which there is a relatively close stand. (3) There is an increasing uniformity in the vegetative character of the dominants.

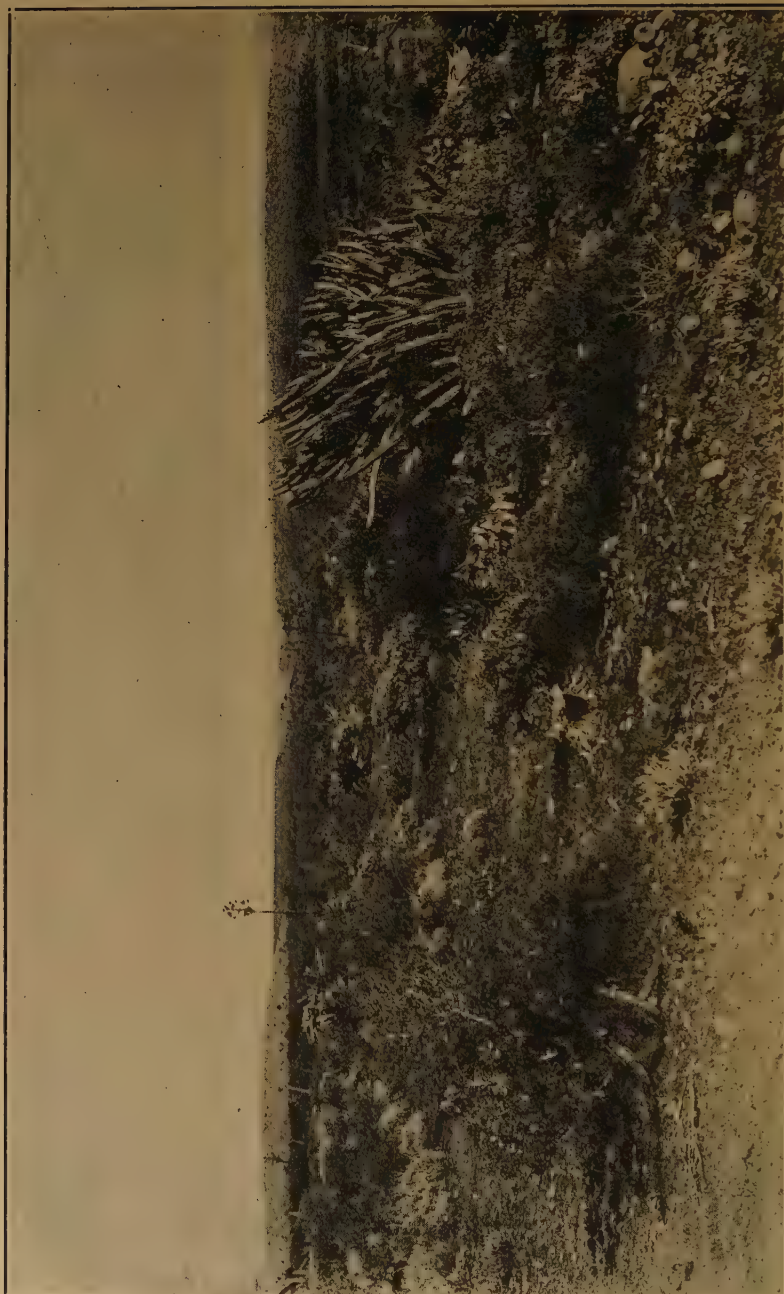

PLATE XIII. Vegetation of the Desert-Chaparral Transition on the Pacific coast of Baja California, thirty miles north of Rosario; looking east. Conspicuous plants are *Machaerocereus gummosus*, *Euphorbia misera*, *Franseria chenopodifolia*, *Agave Goldmaniana*, *Echinocereus maritimus*, *Rosa microphylla* and *Atriplex julacea*.

The mingling in the desert of many types of trees, shrubs, bushes, cacti, yuccas, agaves, and other forms becomes more and more local and infrequent through the transition region. (4) There is a gradual loss of deciduous shrubs and an increasing abundance of evergreen shrubs. With several exceptions the shrubs of central Baja California are either deciduous or else retain their leaves after they have withered from drought. The close stands of shrubbery which are found farthest south in the transition are made up largely of deciduous or semi-deciduous types. Only in the northern part of the transition do the evergreen sclerophylls begin to give the vegetation the character of true chaparral.

Meigs[2] has recently published a map of the climatic and vegetational regions of northern Baja California. The climatic classification follows Köppen's scheme, and the vegetation characterizing each of the subdivisions is very briefly indicated. The southern part of the Desert-Chaparral transition is designated "foggy coastal desert" by Meigs, merging toward the north into "monte," a shrub community occurring in an arid steppe climate. Meigs also describes a series of inland benches extending from the upper course of Rio Guadalupe north to the latitude of Descanso on which the vegetation is predominantly grassland. These areas are north of Ensenada and well beyond the limits of the transition region as here defined, but closer investigation of them will doubtless reveal that they are essentially a part of the transition, due to local soil conditions in conjunction with the steppe type of climate.

In order to convey some indication of the number of perennials found in normal habitats in the transition, and of their relative abundance, the following list is given. It was drawn from an outwash slope near the lower course of Rio San Domingo, about ten miles from the ocean at an altitude of 150 feet in latitude 30° 45′ N. and about twenty miles south of the center of the transition. The area on which the list is based was rather heavily covered with perennials, estimated to occupy from eighty to ninety per cent of the ground surface. The level of the vegetation was irregular, on account of the normal height differences among the component species, and the color tone was varied.

Asterisks indicate the relative abundance. The letters D, T, and C indicate respectively whether the range of the plant is chiefly in desert, transition or chaparral. The height, or common range of height, is also given.

****Franseria chenopodifolia	T D	30 inches
***Rosa minutifolia	T	30 "
***Euphorbia misera	D	20– 40 "

[2] Meigs, Peveril. The Dominican Mission Frontier of Lower California. Univ. of Cal. Press, p. 14. 1935.

***Viguera laciniata	D	40–50	inches
***Machaerocereus gummosus	D	48– 72	"
***Ribes tortuosum	T	40	"
**Viguera deltoidea var.	D	30– 40	"
**Opuntia ciribe	D	20– 30	"
**Simmondsia californica	D T	30	"
**Bergerocactus Emoryi	T	24	"
**Cneoridium dumosum	T	30	"
**Salvia Munzii	T	25	"
**Aesculus Parryi	T	72– 96	"
**Echinocereus maritimus	T		
*Rhus integrifolia	C	96–120	"
*Opuntia prolifera	T		
*Myrtillocactus cochal	D		
*Harfordia macroptera	T		
*Dudleya sp.			
Lycium californicum		40– 50	"
Ferocactus acanthodes	D		
Neomammillaria dioica	T		

From the floristic standpoint the transition region is not merely one in which two distinct floras blend gradually into one another. In the first place the blending is not alike on the part of the two floras, for, as already indicated, the ranges of the desert plants terminate more abruptly than those of the chaparral forms and nearer the outer limit of the vegetation in which they are dominant. Very few characteristic desert species range as far north as the edge of the chaparral at Santo Tomas, but a number of plants identified with the chaparral are found in the desert region for one hundred miles or more south of Rosario. Only two of these, however, are broad-leaved sclerophyll shrubs. In the second place the transition region is characterized by a number of plants which are confined to it or extend only a short way north or south of it. The strongly endemic character of the chaparral indicates its antiquity, and the less pronounced endemism of the transition suggests that there has long been a buffer region between the two very dissimilar vegetations and floras.

Among the dominant plants in the northernmost part of the desert on the Pacific coast of Baja California there are a number which are limited to the desert or occur only in warm situations in the southern part of the transition. These include:

Fouquieria splendens
Idria columnaris
Pachycereus Pringlei
Opuntia clavellina
Agave Nelsoni
Yucca valida
Cercidium microphyllum
Acacia Greggii
Viscainoa geniculata
Parkinsonia aculeata
Solanum Hindsianum
Euphorbia tomentulosa

Echinocereus Engelmannii	Coldenia canescens
Franseria dumosa	Asclepias subulata
Yucca mohavensis	

A smaller number of desert species range north to the central part of the transition and a few of them extend north of Ensenada in close proximity to the ocean, where frosts are rare and light. Among these are:

Myrtillocactus cochal	Euphorbia misera
Opuntia ciribe	Franseria chenopodifolia
Machaerocereus gummosus	Viguera laciniata
Opuntia molesta	Aplopappus venetus var. oxyphyllus
Ferocactus acanthodes	Agave Goldmaniana
Echinocereus maritimus	Acalypha californica

Among the chaparral plants which occur in the northern part of the transition but do not range south of the center of it at lower altitudes are the following:

Ceanothus tomentosus	Ceanothus crassifolius
Rhus integrifolia	Quercus dumosa
Rhamnus ilicifolia	Photinia arbutifolia
Artemisia californica	Prunus ilicifolia

A few species are found in the desert east of the Cuyamaca Mountains and also in the southern chaparral and throughout the transition, including:

Simmondsia californica	Encelia californica
Encelia farinosa	Ephedra californica

A few of the plants associated with chaparral in northern Baja California range to the southern limit of the transition and extend into the desert for distances nearly as great as the length of the transition (one hundred miles) or greater. In the following list of notable examples of this group the distances are given to which each of them extends southward from the northern edge of the desert:

Prunus fasciculata .	80 miles	Ribes tortuosum . . .	130 miles
Isomeris arborea . .	145 "	Rhus laurina	150 "
Eriogonum fasciculatum	130 "	Euphorbia misera . .	105 "
Salvia stachyoides .	70 "	Acalypha californica	145 "

Among the species which are confined to the transition region or do not extend more than fifty miles beyond it are:

Aesculus Parryi	Rosa minutifolia
Adolphia californica	Harfordia macroptera
Romneya Coulteri	Atriplex julacea
Ceanothus verrucosus	Eriodictyon sessilifolium
Bergerocactus Emoryi	Salvia Munzii
Arctostaphylos oppositifolia	Ptelea aptera
Eriogonum fastigiatum	Aplopappus berberidis

It will be noted that the species which are endemic in the transition region are preponderantly of northern relationship. *Adolphia californica* (Rhamnaceae) is very closely related to the only other member of the genus, *A. infesta* of Chihuahua and Hidalgo. *Romneya* (Papaveraceae) and *Harfordia* (Polygonaceae) are ditypic genera. *Bergerocactus* is the only one of the transition endemics of desert affinity. It belongs to a monotypic genus with well-marked characters separating it from the Cereae with which it is most closely allied. The other members of the last list belong to genera richly represented in the north and, except in the case of *Salvia,* either absent or poorly represented in the lower latitudes of North America.

These facts further strengthen the evidence that on the Pacific coast the plants of the desert are more sharply confined to their own formation than are the species and genera of the chaparral and other northern types of vegetation. This appears to be due to the fact that the only requirement for the long southward extension of a chaparral plant is the occurrence in the desert region of relatively moist habitats, however restricted in area, while the northward extension of a desert plant requires a well-drained soil, a high percentage of sunshine and freedom from freezing temperatures of more than a few hours' duration. These more exacting requirements are met only in close proximity to the edge of the desert or else in light soils or on steep south slopes near the sea.

Desert Laboratory of the Carnegie
Institution of Washington,
March 9, 1936.

THE GENUS LEPIDIUM IN THE UNITED STATES

C. Leo Hitchcock

Thellung's Monograph of Lepidium,[1] published in 1906, is the most recent comprehensive treatment of that interesting genus of the Cruciferae. Since that date sixteen species and varieties of *Lepidium* have been described as new for the United States, but many of these, unfortunately, are of no nomenclatural value. In attempting to use Thellung's Monograph, one is convinced that the material which was at that worker's disposal was inadequate for an accurate interpretation of our plants. In fact, Thellung was forced to recognize several of our species without having seen any material which he could refer to them.

It was at the instigation of several American taxonomists, who were unanimous in their opinion that *Lepidium* needed revision, that the present study was undertaken. It is hoped that it will be possible to extend the study of the genus to the South American species in the near future, as the exact status of some of our introduced plants cannot be ascertained until this is done.

The herbaria which have been visited or from which material has been borrowed for study are cited by the following abbreviations in this paper: University of California, Berkeley (C), California Academy of Sciences (CA), Carnegie Institution of Washington at Stanford University (CI), herbarium of Joseph Ewan, Berkeley (E), Field Museum (F), Gray Herbarium (G), University of Illinois (I), herbarium of Louis Wheeler, La Verne, California (LW), University of Montana (M), Missouri Botanical Garden (MBG), New England Botanical Society (NE), New York Botanical Garden (NY), Pomona College (P), Philadelphia Academy of Sciences (PA), Dudley Herbarium, Stanford University (S), United States National Herbarium (US), Rocky Mountain Herbarium, University of Wyoming (W), Washington State College (WSC). The caption "representative material" indicates that only a certain number of the specimens examined by the writer are cited; "material seen" indicates that all specimens examined are cited.

To the curators of these herbaria my thanks are due and gladly given. It is a pleasure to acknowledge the help I have received from Dr. P. A. Munz of Pomona College and from Miss Nell Horner, Librarian of the Missouri Botanical Garden, for the loan of literature; from Dr. Harold St. John of the Bishop Museum who supplied notes and photographs made at Paris from the types of Desvaux; and particularly from Mr. J. T. Howell of the California Academy of Sciences who was kind enough to make observations on the type of *L. Menziesii* at the British Museum and who has supplied much valuable information con-

[1] Denks. Schweiz. Gesell. Naturwiss. 41, abh. 1: 1–340. 1906. Herein cited as 'Monog. Lepid.'

cerning the literature and the field characters of several of the far-western species.

Lepidium L.

Lepidium L. Sp. Pl. 643. 1753, Gen. Pl. 291. 1754; Thell. Monog. Lepid. 72. 1906.

Sprengeria Greene, Leaflets Bot. Obs. and Crit. 1: 198. 1906.

Leaves entire to bi- or tripinnate, sometimes clasping or even perfoliate. Pedicels terete to winged or much flattened. Sepals usually somewhat pubescent on back. Petals lacking, or mere vestiges, or as much as 2–3 mm. long, white to sulfur yellow, glabrous or rarely densely pubescent on back. Stamens 2, 4, or 6. Silicles rotund, ovate, elliptic, obovate, or oblong-ovate, prominently reticulate to smooth, hirsute to glabrous, apex from scarcely winged and barely notched to winged and deeply notched, the apices often divergent; style lacking to as much as 3 mm. long. Seeds 2, cotyledons incumbent to accumbent, entire or bi- or trifid. Low annuals to somewhat suffrutescent perennials, glabrous to hirsute with simple hairs.

Key to Species of Lepidium

Woody-based perennials, or if annuals styles at least 0.3 mm. long, exceeding notch of fruits; if styles shorter, upper cauline leaves perfoliate, or with sagittate or auriculate clasping bases.
  Leaves (at least some of the cauline ones) either perfoliate, or entire and with clasping bases.
    Cauline leaves perfoliate; fruits rhombic-ovate, not greatly inflated .... 2. *L. perfoliatum*
    Cauline leaves sagittate-based; fruits conspicuously inflated.
      Perennial; fruits without conspicuously winged margin and apex .... 4. *L. Draba*
      Annual; fruits with conspicuously winged margin and apex .... 1. *L. campestre*
  Leaves neither perfoliate nor entire and sagittate-clasping.
    Fruits with prominent divergent winged apices; style one-third as long to as long as fruit; petals yellow. 20. *L. flavum*
    Fruits, styles, and petals not as above.
      Plants glabrous and glaucous; fruits 4–7 mm. broad .... 21. *L. Fremontii*
      Plants usually pubescent and not glaucous; fruits less than 4 mm. broad.
        Annual; petals yellow .... 24. *L. Jaredii*
        Annuals, biennials, or perennials, (if annuals the petals white).
          Plants densely hirsute-cinereous or papillose-hirsute; cauline leaves pinnatifid; annuals (biennials?) .... 25. *L. Thurberi*
          Plants not cinereous-hirsute, or if so, cauline leaves practically or quite entire; biennials or perennials.
            Caespitose and matted, 3–6 cm. tall .... 23. *L. nanum*

Erect or at least not caespitose and matted; usually over 6 cm. tall.
Leaves entire or at most but dentate, some, at least, 4–8 cm. broad; fruits somewhat pilose . . . . 5. *L. latifolium*
Leaves pinnate to entire, but if entire, not so broad as above; fruits not pilose.
Silicles emarginate; style 0.3 mm. long or more . . . . 22. *L. montanum*
Silicles not emarginate; style usually less than 0.3 mm. long . . . . 6. *L. graminifolium*
Annuals or perennials, but never woody-based; styles less than 0.3 mm. long, usually shorter than notch of fruit; upper cauline leaves neither perfoliate nor auriculate-based and clasping.
Fruits 1.5–2.2 mm. long; cauline leaves finely pinnatifid or pinnate-pinnatifid, granular puberulent . . . . 13. *L. sordidum*
Fruits over 2.2 mm. long, if fruits 2.2 mm. long or less, leaves not finely pinnatifid and plant not granular-puberulent.
Petals 2 mm. or more long; fruits 5–7 mm. long, apices long-acuminate, winged; if apices otherwise, the cotyledons bi- or trifid.
Cotyledons bi- or trifid; fruits not with acuminate apices, glabrous . . . . 3. *L. sativum*
Cotyledons entire; fruits with long acuminate apices, pubescent . . . . 19. *L. latipes*
Petals less than 2 mm. long usually; if petals 2 mm. long or over, fruits less than 5 mm. long; if fruits 5 mm. long or more then apices not acuminate winged and cotyledons not bi- or trifid.
Stems glabrous or nearly so; cauline leaves 1–4 cm. broad, entire or at most dentate . . . . 5. *L. latifolium*
Stems pubescent or cauline leaves less than 1 cm. broad, or both.
Sepals persistent until fruits are nearly mature; pedicels slightly flattened and wing-margined.
Fruits oval to obovate with rounded apex and sinus, not prominently reticulate . . . . 8. *L. oblongum*
Fruits ovate, prominently reticulate, apex with two acute winged divergent teeth . . . . . . 7. *L. pubescens*
Sepals deciduous along with petals and stamens or soon after; pedicels often decidedly flattened, but scarcely wing-margined.
Fruits emarginate and with prominent, acute, divergent apices, or fruits prominently reticulate, or both.
Pedicels slender, not greatly flattened, some, at least, equal to or longer than fruits; silicles glabrous . . . . 18. *L. oxycarpum*
Pedicels much flattened, not longer than fruits; silicles often pubescent.
Silicles glabrous . . . . 16. *L. nitidum*
Silicles pubescent . . . . 17. *L. dictyotum*
Fruits not emarginate, or if so, the lobes on either side of sinus neither acute nor divergent; fruits not prominently reticulate.
Pedicels much flattened, about twice as broad as thick or broader.

Silicles glabrous.
- Winged margins of fruits broad, slightly upturned usually; segments of leaves linear; stamens usually six .... 16. *L. nitidum*
- Winged margins of fruits narrow and not upturned; leaf-segments not truly linear; stamens mostly less than six.
  - Plants short-hirsute to hirsute-hispid. 15. *L. lasiocarpum*
  - Plants with softer pubescence than above.
    - Leaves prevailing deeply lobed to pinnatifid .... 8. *L. oblongum*
    - Leaves more entire than above .... 11. *L. densiflorum*

Silicles pubescent.
- Margin of fruit upturned, upper surface concave .... 16. *L. nitidum*
- Margin of fruit not upturned, upper surface plain or convex.
  - Pubescence somewhat appressed; lower cauline leaves lobed or sinuate only, at least 7 mm. broad .... 14. *L. austrinum*
  - Pubescence scarcely appressed; cauline leaves mostly more deeply divided and less than 7 mm. broad.
    - Leaves prevailingly deeply lobed to pinnatifid; pubescence neither hirsute-hispid nor hispid .... 8. *L. oblongum*
    - Cauline leaves, at least, usually more entire, but if deeply lobed or pinnatifid, the plant hirsute or hispid .... 15. *L. lasiocarpum*

Pedicels not strongly flattened, not twice so broad as thick.
- Cauline leaves prevailing deeply cleft to pinnatifid .... 8. *L. oblongum*
- Cauline leaves mostly entire, the lower sometimes pinnatifid or deeply cleft, the upper more nearly entire.
  - Plant hirsute; basal leaves entire or but toothed; fruits hirsute, the hairs somewhat appressed .... 14. *L. austrinum*
  - Plant not hirsute; basal leaves usually pinnatifid or at least cleft.
    - Cotyledons accumbent or at least oblique, if oblique the petals exceeding the sepals .... 12. *L. virginicum*
    - Cotyledons incumbent, or if oblique, the petals lacking or shorter than sepals.
      - Fruits obovate or oblong-obovate in outline, the upper half averaging greater in width than the lower half.
        - Silicles nearly elliptic, narrowed to acute apex; congested in numerous axillary reduced racemes as well as in terminal racemes 2–4 cm. long (see also *L. ruderale*). .... 10. *L. ramosissimum*

Silicles oblong to obovate but not elliptic in outline, rounded at apex, borne in racemes over 4 cm. long, normally .... 11. *L. densiflorum*
Fruits ovate to oval in outline, upper half averaging less than lower half in width, or but equal to it.
Perennial; fruits not emarginate. 6. *L. graminifolium*
Annuals or biennials; fruits emarginate.
Fruits ovate-elliptic to elliptic; cotyledons always incumbent; plants often malodorous.
Racemes numerous, compounded, short, 1–4 cm. long .... 10. *L. ramosissimum*
Racemes terminal, not compounded, mostly over 4 cm. long .... 9. *L. ruderale*
Fruits oval to nearly rotund; cotyledons mostly accumbent or oblique (except in var. *medium* f. *pusillum*); plants not malodorous .... 12. *L. virginicum*

1. Lepidium campestre (L.) R. Br. in Ait. Hort. Kew, ed. 2, 4: 88. 1812.

Thlaspi campestre L. Sp. Pl. 646. 1753.

Annual, densely short-villose, simple to profusely branched; leaves oblanceolate, the basal 4–12 cm. long, *ca.* 1 cm. broad, pinnatifid, lyrately lobed to entire, petiolate; cauline denticulate, sessile and sagittately clasping; pedicels slender, slightly flattened, about equal to fruits; sepals *ca.* 1.5 mm. long, villose to glabrate; petals nearly 2 mm. long; stamens 6; fruits oblong-ovate, 5–6 mm. long, 4 mm. broad, pustulose and somewhat hairy to glabrous, margins and apex fairly broadly winged, upper surface concave, apex slightly emarginate; style 0.2–0.6 mm. long, equaling or slightly exceeding the apices; cotyledons incumbent. (Plate XVII, fig. 5.)

An introduced European species well established, especially on waste land, throughout the United States, except in most of the Rocky Mountain States.

Representative material. Massachusetts: Harwich, Barnstable County, *Fernald & Long 18493* (G). West Virginia: Mount Crawford, *Heller 820* (MBG, etc.). Missouri: Fredericktown, *Palmer 30295* (MBG, etc.). Colorado: Mesa Verde Park, *Goodman & Hitchcock 1363* (C, CA, MBG, S). Nevada: Lemmon Valley, Washoe County, *Kennedy 2086* (CA, S). Washington: near Bingen, *Suksdorf 11662* (CA, MBG, PA, S, WSC).

2. Lepidium perfoliatum L. Sp. Pl. 643. 1753.

Annual; basal leaves multifid or multipinnate, cinereous-pubescent to glabrous, cauline leaves variable, lowest finely dis-

sected, middle auriculate, surrounding stem, glabrous or nearly so, upper perfoliate, rounded, glabrous; pedicels slender, terete, glabrous, longer than fruits; sepals ovate, *ca.* 1 mm. long, pilose on back; petals narrow, slightly exceeding sepals; stamens usually 6; silicles rhombic-ovate, *ca.* 4 mm. long and nearly as broad, glabrous or minutely and sparsely pubescent, barely winged at apex, sinus *ca.* 0.2 mm. deep; style about equal to sinus; cotyledons incumbent. (Plate XV, fig. 2.)

A well established European species; very common, especially in central and western United States, chiefly on waste land.

Representative material. MAINE: Portland, *Fernald, Long & Norton 13689* (NE). UTAH: north of Salt Lake City, *Rydberg 6125* (US, W). NEVADA: Pyramid Lake, Washoe County, *Kennedy 2039* (CA, G, W). IDAHO: Lewiston, *Hitchcock & Samuel 2497* (CA, M, P, PA, S, W, WSC). CALIFORNIA: Keddie, Plumas County, *Eastwood 14713* (CA).

3. LEPIDIUM SATIVUM L. Sp. Pl. 644. 1753.

Strict, tall annual; leaves all dissected, pubescent; pedicels appressed, not so long as fruits; sepals pilose on back, slightly over 1 mm. long; petals nearly twice length of sepals; stamens 6; fruits oblong-ovate, 5–6 mm. long, *ca.* 4 mm. broad, glabrous and more or less glaucous, winged and upturned on side and at apex, sinus *ca.* 0.4 mm. deep; style about half equaling sinus; cotyledons bi- or trifid, incumbent. (Plate XIV, fig. 1.)

Occasionally escaped from gardens or introduced on ballast, apparently not becoming established.

Representative material. MAINE: Aroostook County, *Furbish* in 1880 (NE). CONNECTICUT: Easton, *Eames 8387* (G). MASSACHUSETTS: New Bedford, *Hervey* (NE). RHODE ISLAND: Middletown, Newport County, *Simmonds* (NE). WASHINGTON: Bingen, Klickitat County, *Suksdorf 8355* (WSC). OREGON: ballast, Portland, *Suksdorf 1844* (WSC); Clearwater, *Spalding* (G). CALIFORNIA: near Piedmont, Oakland, Alameda County, *Rattan* in 1881 (S).

4. LEPIDIUM DRABA L. Sp. Pl. 645. 1753.

Sparsely pubescent to densely cinereous perennial often with repent stems; leaves oblong to oblong-oblanceolate or oblong-obovate, denticulate to dentate, lower 4–10 cm. long, 2–5 cm. broad, long-petioled, upper sessile and with large clasping bases; pedicels slender, terete, *ca.* 1 cm. long; sepals 1.5–2 mm. long; petals 3–4 mm. long, clawed, fruits triangular-ovate to ovate, much inflated, 3–5 mm. long, 4–6 mm. broad, glabrous,[2] barely retuse; style *ca.* 1 mm. long; cotyledons incumbent; ovules sometimes two in each cell. (Plate XVI, fig. 6.)

An introduced European species now well established in western United States where it is a troublesome weed in some regions; less common in eastern United States.

Representative material. CONNECTICUT: New Milford, *Weatherby 5287* (G, NE). COLORADO: Naturita, Montrose County, *Payson & Payson 3877* (G,

[2] Easily confused with *Hymenophysa pubescens* C. A. Meyer, which has very pubescent fruits that are not at all cordate at base.

MBG, W). IDAHO: north Blaine County, *Macbride & Payson 3083* (CA, G, MBG, P, W). WASHINGTON: 10 miles north of Dodge, Garfield County, *Hitchcock, Samuel, & Crisafulli 2592* (CA, M, P, PA, S, W, WSC). CALIFORNIA: near Yreka, Siskiyou County, *Greene 783* (G, MBG), *Heller 8006* (G); Santa Cruz Island, *Howell 6241* (CA).

Although there is great variation in the material seen, the writer has been unable to delimit varieties in this species. Specimens of the nature of the plants which have been called *L. repens* or *L. Draba* var. *repens* have been seen, but because of the fact that there is every degree of variation from the more common small silicles to the large inflated fruits characteristic of var. *repens*, the latter plants are not being given any particular recognition. The following collections are typical of what has been known as var. *repens*. CALIFORNIA: West Sacramento, Tiger Inn, *Bellue* in 1932 (CA, S, US), fruits greatly inflated; near Westminster, Orange County, *Johnson* (P). WASHINGTON: Yakima, *Nelson 1142* (US). SOUTH DAKOTA: Vermilion, Clay County, *Over 17229* (US).

5. LEPIDIUM LATIFOLIUM L. Sp. Pl. 644. 1753;Morse, Rhodora 26: 197. 1924; Eames, Rhodora 37: 161. 1935.

L. latifolium L. var. *eu-latifolium* Thell. Monog. Lepid. 160. 1906.

Tall perennial from widely spreading underground root system, glabrous or nearly so; leaves all entire to dentate, basal as much as 30 cm. long and 6–8 cm. broad, with petioles nearly equalling blades, cauline leaves reduced but many of them 1–4 cm. broad, upper nearly sessile; racemes numerous, many-flowered, much-compounded; pedicels slender, terete, much longer than fruits; sepals oval, less than 1 mm. long, somewhat pilose on back; petals spatulate, white, *ca.* 1.5 mm. long; stamens 6; silicles ovate-rotund, sparsely pilose, *ca.* 2 mm. long, not emarginate (or but very minutely so), tipped by stigma and almost obsolete style. (Plate XV, fig.5.)

Introduced along the coast in New England in saline soil. Well established in parts of Mexico.

Material seen. MASSACHUSETTS: Peabody, *Morse* in 1924 (G, NE, PA, US). CONNECTICUT: tidal shore, Darien, *Eames 11626* (G), *Eames 11633* (WSC); Noroton Point, *Griscom 21882* (G, NE).

A collection from Smeltzer, Orange County, California, *Ewan 4759*, collected in July, 1931 (E, LW, M, P), is extremely puzzling. Although the collector thought that it was an annual, he was not sure, nor can one decide this point from the collection. The silicles are pilose, elliptic-oval, and about the size of those of *L. latifolium*. Leaves and also flowers are almost lacking, the plant being very heavily loaded with ripe fruits. On the basis of fruit characters the plant should be called *L. latifolium*, but if

it is an annual and had no broader leaves than the few on the specimen, it is probably either *L. ruderale* or some hitherto unreported introduced species.

6. Lepidium graminifolium L. Syst. Nat. ed. 10, 2: 1127. 1759.

Perennial, 3–7 dm. tall, sparsely pubescent; basal leaves dentate or crenate-dentate, mostly spatulate, 2–6 cm. long, *ca.* 1 cm. broad, long-petioled, cauline linear to oblanceolate, mostly entire or some remotely denticulate, 1–3 cm. long, 0.1–0.4 cm. broad; racemes loosely flowered, 2–6 cm. long; pedicels slender, ascending, about equal to fruits, not flattened; sepals *ca.* 1 mm. long, pubescent on back; petals spatulate-obovate, *ca.* 2 mm. long; stamens 6; fruits ovate-elliptic, glabrous, 3–4 mm. long, apex acute, not emarginate, tipped by distinct though very short (*ca.* 0.2 mm. long) style and stigma. (Plate XVII, fig. 3.)

Introduced along the coast occasionally on ballast, but not established in the United States.

Material seen. New Jersey: ballast, near Communipau Ferry, *Brown* in 1879 (G); Camden, *Martindale* in 1880 (PA), *Albrecht* in 1898 (PA). Pennsylvania: piers 82 and 825, Philadelphia, *Meredith* in 1920 (PA). Oregon: ballast, Linnton, *Nelson 503* (G).

The fruits of the species are most like those of *L. ruderale* in shape, but they are not emarginate, and the style and stigma are plainly visible.

7. Lepidium pubescens Desv. Journ. Bot. 3: 165, 180. 1814.

L. reticulatum Howell, Fl. Northwest Amer. 1^1: 64. 1897. This is the only representative of this group from southwestern Oregon.

L. oxycarpum var. (?) *strictum* Wats. Bot. Calif. 1: 46. 1876. The type, collected by Rattan, near Placerville, California, is good representative material.

L. strictum Rattan, Anal. Key 25. 1888.

Pubescent annual, spreading to erect, branches 5–20 cm. long; leaves bipinnatifid to laciniately lobed, the divisions linear, not over 2–3 mm. broad, the basal 3–7 cm. long, 1–2 cm. broad, glabrous or with few hairs chiefly on petioles; racemes crowded, seldom over 4–5 cm. long; pedicels scarcely as long as fruits, erect, or but slightly spreading, somewhat flattened and with winged margins, lower surface glabrous or nearly so; sepals slightly less than 1 mm. long, often purplish, pilose on back, persistent until fruit is nearly mature; petals minute; stamens 2; silicles ovate to ovate-rotund, 2.25–3 mm. long, nearly as broad, distinctly reticulate, glabrous or the margin with few short hairs, biconvex, thickest portion just above center of fruit, with small winged apex, the sinus open and the two teeth slightly spread-

ing, *ca.* one-sixth length of whole fruit; style lacking; cotyledons incumbent. (Plate XIV, fig. 3.)

An introduced South American species, fairly widespread in California; at Portland and in southern Oregon; collected once in Utah.

Representative material. UTAH: Castle Gate, Carbon County, *Grant* in 1900 (S). OREGON: Woodville, *Howell* in 1889 (MBG), *Howell 1909* (NY); Umpqua Valley, *Howell* in 1881 (NY). One of these last three collections is probably the type collection of *L. reticulatum* Howell. CALIFORNIA: without locality, *Rattan* in 1878 (NY); Hoopa Valley, Humboldt County, *Rattan* in 1878 (G); Potter Valley, Mendocino County, *Eastwood* in 1925 (CA); Sycamore Slough, Colusa County, *Ferris 695* (NY); Kelseyville, Lake County, *Blankinship* in 1929 (MBG); Petaluma, *Congdon 300* (G); near Napa, *Heller & Brown 5363* (F, G, MBG, NY, P, PA, S, W); near Placerville, *Rattan* (G, type of *L. oxycarpum* var. *strictum*); Kentfield, Marin County, *Eastwood 18* (CA, F, NY, US); San Francisco, *Jones 3272* (CA, F, MBG, NY, P, S); Stanford University, *Abrams 1648* (MBG); Pacific Grove, *Heller 6633* (F, G, MBG, NY, PA, S); Visalia, *Congdon 461* (G); Glenville, Kern County, *Howell 5145* (CA); Santa Catalina Island, *Trask* in 1901 (NY); Los Angeles, *Chamberlain* (NY). The two following collections are tentatively placed here: the fruits are much less reticulate than usual, are not truly biconvex, and the apices are not divergent, but otherwise they are fairly similar to those of the above plants; the sepals are persistent, the leaves are similar, and the pedicels are wing-margined: Portland, Oregon, *Suksdorf 3193, 3235* (WSC).

The species name *pubescens* is being used provisionally for this entity chiefly because that is the name in common usage since Thellung's Monograph. However, judging from notes made at Paris by Dr. Harold St. John, and from the excellent photograph he sent me of Desvaux's type, I feel fairly certain that our species, although undoubtedly introduced from South America, is not the same as *L. pubescens* Desvaux.

8. LEPIDIUM OBLONGUM Small, Fl. Southeastern U. S. 468, 1331. 1903.

L. reticulatum Thell. Monog. Lepid. 196. 1906. Not *L. reticulatum* Howell.

L. Greenei Thell. Monog. Lepid. 253. 1906 (footnote).

Annual, much branched, diffuse to ascending, 5–20 cm. tall, hirtellous to villose-hirsute; leaves pinnatifid to laciniately cleft or lobed, the basal ones about 3 cm. long, nearly 1 cm. broad, with lobed pinnae, cauline ones smaller, laciniate only, the central rachis as much as 3–4 mm. broad; racemes numerous, 6–9 cm. long; pedicels scarcely as long as fruits, ascending to spreading, flattened somewhat, but scarcely wing-margined; sepals slightly more than 1 mm. long, persistent only for a short time after flowering; petals wanting or but linear vestiges; stamens 2; silicles glabrous or sparsely short-pectinate, oval to oblong-obovate, 2.5–3.5 mm. long and 2–3 mm. broad, indistinctly reticulate, narrow winged margin sometimes slightly upturned, apices rounded except for small v-shaped sinus one-sixth to one-eighth

the length of the whole fruit; stigma sessile or essentially so; cotyledons incumbent. (Plate XIV, fig. 4.)

Collected at widely scattered stations: Oklahoma, Arkansas, Texas, southern Arizona, southern and central California, Mexico; probably a native of South America.

Representative material. ARKANSAS: Corning, *Letterman* in 1884 (G, MBG); Hope, *Letterman* in 1884 (MBG); Texarkana, *Pringle* in 1883 (F, NY). OKLAHOMA: Ingersoll, *Bush 1505* (MBG, NY); near Alva, *Stevens 3008* (G, MBG, S, US); Sapulpa, *Bush 1163* (MBG, NY type); Huntsville, *Blankinship* in 1896 (G). TEXAS: Comanche, *Eggert* in 1900 (MBG); Sweetwater, *Palmer 13708* (MBG, US); near Lubbock, *Demaree 7442* (MBG), *Studhalter 1115,* silicles pubescent (US); Canyon, *Palmer 14011* (MBG, US). ARIZONA: Picture Rocks, Pima County, *Bartram 104* (PA, W); Santa Rita Mountains, *Griffiths 2186* (NY); Sacaton, *Peebles 704* (US). CALIFORNIA: Shattuck Avenue, Berkeley, *Davy* in 1900 (C); Del Mar, San Diego County, *Brandegee* in 1894 (C).

In general, there seems to be some difference between the material from Arizona and the more eastern states and that of southern California. The fruits of the California plants are somewhat larger and pubescent on the margins (of the above collections from other states only *Studhalter 1115* has pubescent silicles), the leaf-divisions are somewhat narrower, and there seems to be less tendency for the sepals to be persistent. They were at first thought to be more closely related to *L. lasiocarpum* than to the other plants which Small called *L. oblongum,* and much of the material examined was annotated as a new variety of *L. lasiocarpum.* However, as more material has been studied, the similarity between the plants from the two regions has become more obvious and the collections mentioned below are therefore somewhat hesitantly referred here.

Representative material. CALIFORNIA: San Bernardino, *Parish 4628* (NY, S, US), *Parish & Parish 64* (MBG); Fairmount Park, Riverside County, *Wilder* in 1908 (C); El Centro, *McGregor 2012* (P); near San Luis Obispo, *Roadhouse 382* (US); San Nicolas Island, *Trask 28* (G, MBG), *Howell 8208* (CA); San Miguel Island, *Munz & Voss 11878* (P); Santa Cruz Island, *Hoffmann* in 1930 (CA); Santa Catalina Island, *Trask* in 1901 (MBG); Los Angeles, *Brewer 27* (G); Santiago Creek, Orange County, *Geis* in 1902 (P); San Diego, *Pringle* in 1882 (F, G, MBG, NY), *Orcutt* in 1884 (US), *Jones 3050,* first number cited by Thellung under *L. Robinsonii* (CA one sheet only, P, but not second sheet at CA, nor sheets at I, MBG, NY, US, WSC), *Jones 3051* (CA, MBG, NY one sheet only, P, PA, US); Sweetwater, *Orcutt 1038* (F, MBG); Ramona, *Brandegee* in 1906 (G).

Although it is fairly certain that this is a South American species which has been introduced into Mexico and the United States, I have been unable to determine with certainty the correct name for the material. It seems probable that it is either *L. auriculatum* Regel and Körnicke or *L. bipinnatifidum* Desv. Dr. Harold St. John, who compared material of this species from Arkansas and from southern California with the type of *L. bipinnatifidum* at Paris, ventured the opinion that they are not con-

specific. Judging from his notes and photograph of Desvaux's type, I am prone to agree with him. However, until such time as this problem can be solved, it seems best to use the oldest North American name for the species. Since these are not the plants which Howell had in mind when he described *L. reticulatum,* the name here used is *Lepidium oblongum.*

Lepidium Greenei, a name which Thellung proposed for the plants he was calling *L. reticulatum* if that species proved not to be the same as Howell's species, must be relegated to synonymy. Thellung's confusion on this point resulted, of course, from the fact that he did not see type material of either *L. reticulatum* or *L. oblongum.*

The group may be distinguished from *L. pubescens* by the less divided leaves, by the non-winged pedicels, and by the fruits, which are neither biconvex nor so prominently reticulate and which are oval to obovate, rather than ovate.

9. Lepidium ruderale L. Sp. Pl. 645. 1753.

L. texanum Buckley, Proc. Am. Acad. Sci. Phila. 1861: 449. 1862. The type was collected by Buckley, near Fort Mason, Texas, June, 1861.

Foetid, freely branched, minutely pubescent annual (biennial?) 1.5–5 dm. tall; basal leaves pinnatifid to bipinnatifid, lower cauline somewhat divided, upper linear and entire; racemes mostly 5–8 cm. long, open, not compounded or leafy; pedicels equaling or slightly exceeding fruits, usually slightly ascending, terete; sepals *ca.* 1 mm. long, linear, 3–4 times as long as broad, pubescent on back; petals lacking entirely (in specimens examined); stamens 2; silicles glabrous usually, 2–3 mm. long and *ca.* two-thirds as broad, ovate-elliptic to nearly oval, shallowly notched at apex, the sinus rather open, one-sixth to one-tenth length of fruit; style lacking; cotyledons incumbent. (Plate XIV, fig. 6.)

Introduced from Europe, fairly common in northeastern United States and Nova Scotia; occurring also in Texas, Michigan and Oregon, but rare and perhaps not established in the latter two states.

Representative material. Maine: Portland, *Fernald* in 1897 (G). New Hampshire: Portsmouth, *Robinson 690* (G, NE). Massachusetts: Cambridge, *Deane* in 1889 (G), *Fernald* in 1891 (G, NE). Rhode Island: Providence, *Collins* in 1892 (G). New York: Albany, *Burnham* in 1911 (G). New Jersey: Kaighn's Point, Camden, *Parker* in 1871 (C, G). Delaware: Wilmington, *Commons* in 1900 (G). Michigan: near Forest, Lampton County, *Dodge 11* (US). Louisiana: Natchitoches, *Palmer 7527* (US). Texas: near Long Lake, Anderson County, *Eggert* in 1899 (MBG); Bastrop, *Duval 2* (US); Lyons, *Gresenschlag 7238* (US); Dallas, *Reverchon 2199* (MBG). Oregon: Linnton, near Portland, *Suksdorf 1934* (G, WSC), *Nelson 845* (G).

The fruits of *L. ruderale* are very similar to those of *L. ramosissimum* and it seems that the two species may be related more

closely than has been supposed. *L. ruderale,* however, differs in the following respects. The plant is foetid, it is much less pubescent, the hairs are usually shorter; the sepals are less broad; petals are usually entirely lacking; pedicels are more slender and not flattened; fruits are somewhat broader and more ovate than truly elliptic, and the winged apices are less prominent.

It is with some misgiving that the writer has included here *L. texanum* Buckley. Most workers have considered this species to be more closely related to the *L. virginicum* complex. However, Buckley's type can be fairly well matched by collections of *L. ruderale* from Europe, and careful search has failed to reveal distinguishing characters of specific value.

As mentioned above, there is close relationship between *L. ramosissimum* and *L. ruderale. Lepidium texanum* seems to be more or less intermediate between the two, but closer to the latter. Further field study might show that *L. ramosissimum* and *L. texanum* are both varieties of *L. ruderale* proper.

The following collections are representative of the type of plant which Buckley called *L. texanum.* Texas: west of Pecos, *Tracy & Earle 382* (MBG); near Comanche, *Eggert* in 1900 (MBG); near Fort Mason, *Buckley* in 1861 (PA, type, photograph at M).

10. Lepidium ramosissimum Nelson, Bull. Torr. Bot. Club 26: 124. 1899.

L. ramosissimum var. *robustum* Thell. Monog. Lepid. 236. 1906. Of no taxonomic value; the type, collected in Saskatchewan in 1858, *Bourgeau,* is too immature for the linear cauline leaves to be evident.

L. divergens Osterhout, Bull. Torr. Bot. Club 30: 237. 1903. *Osterhout 2642,* the type, collected at Tennessee Pass, Lake County, Colorado, is a low growing, glabrous fruited form that is not branched so much as most material.

L. Fletcheri Rydberg, Bull. Torr. Bot. Club 34: 428. 1907. The type, collected by Fletcher at Winnipeg, is a simple plant with cauline leaves that are more divided than usual. The fruits have a rather open sinus, but are not truly obovate, as described, and are well within the range of variation of *L. ramosissimum.*

Profusely branched (rarely simple) biennial (annual?), densely though finely pubescent to pulverulent, 1.5–5 dm. tall; basal leaves pinnatifid, the lobes often again toothed, upper cauline leaves (second year leaves) entire and linear, lower cauline leaves oblanceolate or oblong and few-toothed; inflorescence of many few-flowered corymb-like racemes in axils of upper leaves, terminated by longer fairly open racemes 2–4 cm. long, whole stem thus densely floriferous and leafy; pedicels about equaling fruits, ascending to spreading, slightly flattened and somewhat

wing-margined; sepals *ca.* 1 mm. long, oblong, nearly half as broad as long, pubescent on back; petals linear, not so long as sepals; stamens 2; fruits 2.5–3.5 mm. long, often ciliate or uniformly pubescent, elliptic or nearly so, shallowly notched and winged at apex, the sinus one-sixth to one-eighth length of fruit, open; style lacking; cotyledons incumbent. (Plate XV, fig. 3.)

In the Rocky Mountains, from Manitoba to New Mexico.

Representative material. Canada: railroad ballast, Matane, Matane County, Quebec, *Fernald & Pease 25103* (G); Schreiber, Thunder Bay District, Ontario, *Pease & Bean 23562* (G); Winnipeg, Manitoba, *Thompson 25* and *54* (MBG), *Fletcher* in 1902, type of *L. Fletcheri* (NY); Lake Winnipeg Valley, *Bourgeau* in 1857 (G); Saskatchewan, *Bourgeau* in 1858, type collection of var. *robustum* (G); Banff, Alberta, *Sanson* in 1902 (F, P). United States: North Dakota: Leeds, Benson County, *Lunell* in 1904 (G); Sheyenne, Eddy County, *Lunell* in 1908 (NY). Montana: Westby, *Larsen 36* (MBG); St. Mary's Lake, Glacier National Park, *Standley 17322* (US); Anaconda, *Blankinship 766* (F, M, MBG, P, W). Wyoming: near Big Piney, Sublette County, *Payson & Payson 4360* (G, MBG, PA, W, WSC); Centennial, *A. Nelson 7990* (G, I, MBG, NY, P, W); Laramie, *A. Nelson 1424* (MBG, NY, W type). Colorado: near Grand River, Hot Sulphur Spring, *Nelson 9776* (C, E, MBG, W); Wolcott, *Osterhout 2665* (NY, W); Tennessee Pass, *Osterhout 2642*, type collection of *L. divergens* (NY, P, PA, W); near Trout Lake, San Miguel County, *Payson & Payson 4135* (C, G, MBG, S, W). New Mexico: Rio Fernando de Taos Canyon, *Eggleston 19283* (NY, US); Santa Rosa Area, Guadalupe County, *Nelson 11337* (C, W), racemes less aggregated than usual. Washington: Long Lake, *Macoun 28* (G). California: Chollas Valley, San Diego County, *Cleveland* in 1886 (CA). The last two collections are the only ones seen from the respective states and are apparently chance introductions.

11. Lepidium densiflorum Schrad. Ind. Sem. h. Götting. 4. 1832.

Annual, 3–5 dm. tall, diffusely branched, pulverulent or puberulent to pubescent; leaves mostly oblanceolate, basal 4–6 (10) cm. long, 1.5–2 cm. broad, coarsely toothed to pinnatifid, the divisions also toothed, cauline reduced, entire or at most toothed; racemes numerous, 6–15 cm. long, many-flowered, the pedicels more or less flattened, especially on the under side, usually somewhat appressed or but moderately spreading, scarcely equaling fruits; sepals *ca.* 1 mm. long, usually somewhat pilose on back; petals usually lacking, or but rudiments (seldom equaling sepals); stamens 2 (4 rarely); fruits from obovate to oblong-obovate, 2–3.5 mm. long, with rather conspicuous narrow notch in the winged apex, very obscurely reticulate, glabrous to finely and densely pubescent; style obsolete, the stigma sessile or practically so; cotyledons incumbent (rarely somewhat oblique). (Plate XIV, fig. 2.)

The name *L. densiflorum* is used arbitrarily for this species since the writer has had no opportunity to study the various European types involved. This species differs from *L. virginicum* in that the fruit is decidedly obovate or oblong-obovate rather than rotund or elliptic-rotund, also the upper half of the fruit averages greater in width than the lower half. The usually in-

cumbent position of the cotyledons of *L. densiflorum* is also of help in separating the two species. From *L. ruderale* it differs chiefly in the obovate to oblong-obovate fruits. They are certainly neither elliptic nor ovate-elliptic. From *L. lasiocarpum* it differs as pointed out in the discussion under *L. densiflorum* var. *ramosum*.

KEY TO VARIETIES OF L. DENSIFLORUM

Fruits averaging about 2.5 mm. long, more elliptic-ovate or obovate-rotund than oblong-obovate; pedicels but slightly flattened . . . . 11a. *L.densiflorum* var. *typicum*

Fruits averaging 3 mm. long or slightly more, more oblong-obovate than obovate-rotund; pedicels rather conspicuously flattened.
  Pedicels flattened on both upper and lower sides, about twice as broad as thick . . . . 11e. *L. densiflorum* var. *ramosum*
  Pedicels flattened chiefly on lower side, not twice so broad as thick.
    Silicles glabrous . . . . 11b. *L. densiflorum* var. *Bourgeauanum*
    Silicles pubescent.
      Pubescence confined to margins only . . . . . . 11c. *L. densiflorum* var. *elongatum*
      Silicles uniformly pubescent . . . . 11d. *L. densiflorum* var. *pubicarpum*

11a. LEPIDIUM DENSIFLORUM var. TYPICUM Thell. Bull. Herb. Boiss. ser. 2, 4: 706. 1904.

L. densiflorum Schrad. Ind. Sem. h. Götting. 4. 1832.

L. densiflorum var. *typicum* Thell. Monog. Lepid. 234. 1906, as regards plants of Europe and eastern United States.

L. ruderale and *L. apetalum* in whole or in large part as considered by most early American authors.

L. neglectum Thell. Bull. Herb. Boiss. ser. 2, 4: 708. 1904; Monog. Lepid. 237. 1906. (See discussion below.)

Fruits smaller (*ca.* 2.5 mm. long) than in western varieties, somewhat obcordate-rotund or obovate-rotund; pedicels but slightly flattened; racemes usually quite elongate; cauline leaves mostly toothed.

Common weed in Canada and in most states east of the Rocky Mountain area, rare in the Rocky Mountain and Pacific states.

Representative material. KANSAS: Riley County, *Norton 25* (F, NY, W), cited by Thellung as *L. neglectum;* Cherokee County, *Hitchcock 25a* (G, MBG, NY, US, W), also cited by Thellung as *L. neglectum.* IOWA: Ames, *Pammell 45* (MBG, NY). MISSOURI: Courtney, *Bush 781, 8898, 9758, 9756* (MBG and various other herbaria). OKLAHOMA: Waynoka, Woods County, *Stevens 605½* (G). TEXAS: north of Valley Springs, Llano County, *Cory 6225* (G). MONTANA: Bozeman, *Blankinship 57* (F, M, MBG, PA, W); Fort Missoula, *Jones* in 1909 (P). COLORADO: Grand Junction, Mesa County, *Eastwood 5159* (CA). UTAH: Marysvale, Piute County, *Jones 5338f* (P). ARIZONA: Flagstaff,

Coconino County, *Hanson & Hanson A708* (MBG). Oregon: Portland, *Nelson 2895* (G). California: Yosemite Valley, *Abrams 4382* (C, G, P, S).

Lepidium neglectum Thell. is not maintainable as a species in the writer's opinion. The material which Thellung cited is mostly fairly representative of *L. densiflorum* var. *typicum*. However, considering how extremely common *L. virginicum* and *L. densiflorum* are in the eastern and central states, it would not be surprising to find evidence of hybridization between the two. Several collections have been studied which are intermediate in character between these two species and which are suspected of being hybrid in origin. Plants of such a nature are: Missouri: East St. Louis, *Eggert* in 1886 (CA, US); Courtney, *Bush 781* (MBG, US); Illinois: Salem, *Bebb* in 1862 (US); New Jersey: Swedesboro, *Lippincott* in 1897 (PA); eastern Pennsylvania: *Porter* in 1898 (PA). All these collections are apetalous or nearly so and the fruits are about as large as those of *L. virginicum* but are shaped more like those of *L. densiflorum*. On the whole, since the cotyledons are incumbent, they are more similar to the latter species, and are therefore cited here.

11b. Lepidium densiflorum var. Bourgeauanum (Thell.) comb nov.

L. Bourgeauanum Thell. Monog. Lepid. 237. 1906. The type, collected by Bourgeau in Saskatchewan in 1857–58, has not been seen, but description leaves little doubt of the identity.

Silicles somewhat oblong, glabrous, averaging 3 mm. long; pedicels flattened somewhat on both surfaces, but not twice so broad as thick.

Fairly common in western Montana, Wyoming, Colorado, Nevada, Idaho, eastern Washington and Oregon, northern California, and Arizona; western Canada to Alaska.

Representative material. Montana: Spanish Basin, Gallatin County, *Rydberg & Bessey 4140* (M); Missoula, *Hitchcock 2311* (M). Wyoming: Yellowstone River, *Nelson & Nelson 5745* (G, MBG, P, W, but not NY); Powder River, *Nelson 9369* (G, MBG, NY, P, S, W); Laramie, *Nelson 8233* (C, F, P, S, W). Colorado: Paradox, Montrose County, *Walker 97* (G, MBG, P, S, W), approaching var. *typicum*. Utah: Modena, Iron County, *Goodding 1012* (C, F, G, MBG, P, W). Arizona: Alpine, Apache County, *Goodding 1257* (NY). Nevada: Calientes, Lincoln County, *Tidestrom 9511* (US); Reno, *Jones* in 1897 (MBG, P). Idaho: Boise, *Clark 133* (C, F, MBG, P, S, W), approaching var. *typicum;* Plymouth, Canyon County, *Macbride 179* (C, F, G, MBG, W, WSC). Washington: near Bingen, *Suksdorf 11862* (C, CA, I, MBG, S, WSC); east of Spokane, *Suksdorf 8850* (WSC). California: near Mokelumne River, Colusa County, *Rattan* in 1880 (S). A collection made near Pony, Madison County, Montana, *Rydberg & Bessey 4141* (M), approaches var. *elongatum*. Two collections from Siskiyou County, California, are intermediate between this variety and var. *ramosum:* Yreka, *Butler 1612* (C, CA, MBG, P, S, W); near Sisson, *Heller 12561* (CA, F, G, I, MBG, S).

These plants have not been recognized as distinct from the eastern variety by other workers, but the differences in size and

shape of the fruit (as indicated in the key) are quite constant. The varietal name *Bourgeauanum* is adopted because it seems quite certain that Thellung's species cannot be maintained and, judging from the description, leaves, flowers, and fruits all come within the range of variation of the western variety of *L. densiflorum.*

11c. Lepidium densiflorum var. elongatum (Rydberg) Thell. Bull. Herb. Boiss. ser. 2, 4: 706. 1904; Monog. Lepid. 235. 1906.

L. elongatum Rydberg, Bull. Torr. Bot. Club 29: 234. 1902.

L. simile Heller, Bull. Torr. Bot. Club 26: 312. 1899. The type, *Heller & Heller 3044a,* is practically identical with *Heller 21,* the type of *L. elongatum.*

Silicles oblong, *ca.* 3.5 mm. long, pubescent on margins only; pedicels somewhat flattened; cotyledons sometimes somewhat oblique.

Western Idaho, eastern Washington, and northern Oregon; north to British Columbia.

Representative material. Idaho: McCammon, Bannock County, *Nelson & Nelson 5404* (S, W, WSC); near Lewiston, *Hitchcock, Samuel, & Crisafulli 2509* (CA, M, P, S, W, WSC), *Heller & Heller 3044a,* type collection of *L. simile* (MBG, NY), *Heller & Heller 3008* (C, MBG, NY, PA, S, WSC). Washington: Almata, Whitman County, *Elmer 21* (C, MBG, NY type, W); near Asotin, *Hitchcock, Samuel, & Crisafulli 2555* (CA, M, P, S, W, WSC); Ellensburg, *Thompson 8328* (E, NY, PA); Columbia River, Klickitat County, *Suksdorf 1942* (C, F, G, MBG, WSC). Oregon: Pendleton, *Jones* in 1905 (P, S); east of Stein's Mountains, Harney County, *Henderson 8424* (CA); John Day Valley, Gilliam County, *Henderson 5050* (CA, G, MBG, S); near Portland, *Suksdorf 3232* (WSC), *Nelson 3071* (G).

11d. Lepidium densiflorum var. pubicarpum (Nelson) Thell. Bull. Herb. Boiss. ser. 2, 4: 705. 1904; Monog. Lepid. 235. 1906.

L. pubicarpum Nelson, Bot. Gaz. 30: 189. 1900. *Nelson & Nelson 6793,* although second number cited by Nelson, was designated the type collection by Thellung and seems most representative of the two collections which Nelson mentioned.

Whole silicle pubescent, averaging 3–3.5 mm. long; pubescence soft, not stiff as in *L. lasiocarpum;* pedicels not greatly flattened.

From central Montana to Utah, west to extreme northwestern California, and occasionally in Oregon and Washington. Apparently most common in Utah.

Representative material. Montana: 12 miles southeast of Harlowton, *Hitchcock 2405* (M); Dwelle's, Gallatin County, *Nelson & Nelson 6793* (G, MBG, NY, W type). Wyoming: Nez Perces Creek, Yellowstone National Park, *Nelson & Nelson 6235,* first number cited by Nelson (W); Snake River, Teton County, *Williams 774* (CA, MBG, NY). Utah: Red Rock Canyon, near Salt Lake City, *Rydberg 6085* (NY, W). Nevada: Humboldt Mts., *Torrey 19* (G, NY); Palisade, Eureka County, *Jones 3785* (CA, MBG, NY, P, S). Idaho: Silver City, *Macbride 390* (C, F, G, MBG, NY, W, WSC); Devil Creek, Owyhee County, *Nelson & Macbride 1737* (MBG, NY, W). Washington: Waitsburg,

Walla Walla County, *Horner R4B74* (G). OREGON: near Cascades, Hood County, *Henderson 78* (G). CALIFORNIA: Big Valley, Lassen County, *Baker & Nutting* in 1894 (C); Goose Valley, Shasta County, *Eastwood 743* (CA, G, PA).

11e. LEPIDIUM DENSIFLORUM var. RAMOSUM (Nelson) Thell. Bull. Herb. Boiss. ser. 2, 4: 706. 1904.

L. ramosum Nelson, Bull. Torr. Bot. Club 26: 125. 1899. Type, *Nelson 4682,* from Granger, Wyoming.

L. densiflorum var. *pubecaule* Thell. Bull. Herb. Boiss. ser. 2, 4: 706. 1904. The type collection, *Fendler* in 1845, without locality, has not been seen by the writer, but the second collection cited, *Heller & Heller 3673,* is undoubtedly var. *ramosum* (G, MBG, P, S). *Heller & Heller 3673* at Washington State College, however, is *L. virginicum.*

Fruits *ca.* 3.5 mm. long, glabrous; pedicels conspicuously flattened on both surfaces, nearly twice as broad as thick.

Southwestern Wyoming to northwestern New Mexico, west to Nevada, sporadically in Arizona and eastern California.

Representative material. WYOMING: Granger, *Nelson 4682* (NY, W type); Point of Rocks, *Nelson 3092* (MBG, W). COLORADO: without locality, *Brandegee 1242* (G, MBG); Grand Junction, Mesa County, *Jones* in 1883 (P). NEW MEXICO: without locality, *Baker 355* (MBG, NY, P); near Santa Fe, *Heller & Heller 3673,* cotype collection of var. *pubecaule* (G, MBG, P, S, but not WSC). UTAH: Chepeta Well, *Jones* in 1908 (P); Thompson's Springs, *Rydberg & Garrett 8330* (W); Salt Lake City, *Jones 1430* (F, P, WSC); Green River near Flaming Gorge, *Williams 450* (CA, MBG, W). NEVADA: near Ely, *Keck 617* (P); Truckee Pass, *Kennedy 1596* (CA); Gardnerville, *Baker 1086* (C, CA, G, MBG, P, W). CALIFORNIA: Barstow, *Parish 9666* (S).

Although *Lepidium densiflorum* var. *typicum* is so different from all forms of *L. lasiocarpum* that there seems to be scarcely any relationship between them, var. *ramosum* so closely approaches in character some specimens of *L. lasiocarpum* var. *georginum* that one can scarcely distinguish them. This intergradation is so gradual and complete that the question is raised as to whether it would not be more correct to consider *L. ramosum* a variety of *L. lasiocarpum.* However, when the varieties *pubicarpum, elongatum,* and *Bourgeauanum* are studied, it can be seen that var. *ramosum* grades into each of these varieties, and that the relationship is really much closer to *L. densiflorum* than to *L. lasiocarpum.*

12. LEPIDIUM VIRGINICUM L. Sp. Pl. 645. 1753.

Annual, freely branched, 1.5–6 dm. tall, sparingly pubescent to rather densely hirsute; leaves irregularly toothed or incised to pinnatifid, the divisions often again dissected, basal sometimes as much as 15 cm. long and 5 cm. broad, upper cauline much reduced and usually entire or but remotely toothed; racemes numerous, many-flowered; pedicels slender, terete or

nearly so, erect or spreading, usually somewhat longer than fruits; sepals glabrous or slightly pilose on back, *ca.* 1 mm. long; petals from about equal to sepals to 2 or 3 times as long, rarely minute; stamens 2, sometimes 4, rarely 6; fruit glabrous, from elliptic-rotund to nearly orbicular, 2.5–4 mm. long, scarcely margined, shallowly notched at apex, the style practically lacking, the stigma usually well included in the shallow notch, upper surface flat or slightly concave, very obscurely reticulate; cotyledons accumbent to oblique or practically incumbent. (Plate XV, fig. 1.)

Key to Varieties of L. virginicum

Cotyledons accumbent .... 12a. *L. virginicum* var. *typicum*

Cotyledons oblique to incumbent.
- Upper portion of stem and pedicels glabrous.
  - Cotyledons incumbent; fruits 2.25 mm. long or less .... 12e. *L. virginicum* var. *medium* f. *pusillum*
  - Cotyledons oblique; fruits mostly over 2.25 mm. long .... 12d. *L. virginicum* var. *medium*
- Entire stem, as well as pedicels, puberulent to cinereous-hirsute.
  - Cauline leaves mostly simple, or at most but incised; cotyledons usually oblique; plants usually 3–6 dm. tall .... 12b. *L. virginicum* var. *pubescens*
  - Cauline leaves with narrow lobes, or parted; cotyledons practically incumbent; plants 1–2 dm. tall .... 12c. *L. virginicum* var. *Robinsonii*

12a. Lepidium virginicum var. **typicum** nom. nov.

L. virginicum L. Sp. Pl. 645. 1753.

L. virginicum subsp. *eu-virginicum* Thell. Monog. Lepid. 225. 1906, in large part.

L. virginicum subsp. *eu-virginicum* var. *pinnatisectum* O. E. Schultz, in Urban Symb. Antill. III, 3: 495. 1903, as treated by Thellung (Monog. Lepid. 229. 1906), as to specimen cited from New York.

L. virginicum subsp. *texanum* Thell. Monog. Lepid. 224, 229. 1906, in part.

L. virginicum var. *linearifolium* Farwell, Am. Midland Nat. 12: 121. 1930. Plant with reduced, narrow upper leaves; not unusual.

Fruits usually somewhat longer than broad; cotyledons accumbent; otherwise much as in the pubescent-stemmed western varieties.

Eastern and central United States and Canada to Texas, Oklahoma, Iowa, and the Dakotas; sometimes introduced farther west.

Representative material. MASSACHUSETTS: Monson, Hampden County, *Seymour 675* (G, MBG). NEW JERSEY: Atlantic City, *Redfield 478* (MBG). PENNSYLVANIA: Long Pond, Luzerne County, *Heller & Halbach 500* (G). VIRGINIA: Portsmouth, Norfolk County, *Rugel* in 1840 (MBG). SOUTH CAROLINA: Manning, Clarendon County, *Stone 451, & 549* (PA). FLORIDA: Myers, Lee County, *Hitchcock 2* (G, MBG). MISSISSIPPI: Chandeleur Island, *Tracy 5046* (MBG). LOUISIANA: Natchitoches, *Palmer 7527* (CA, MBG, US). TEXAS: Galveston, *Tracy 9195* (F, G, MBG). MICHIGAN: Lake Linden, *Farwell 10536,* var. *linearifolium* of Farwell (M), *Farwell 11135* (M); Mo. Bot. Gard., St. Louis, *Hitchcock 2652* (M). NEBRASKA: *Goodding 2219* (MBG). CALIFORNIA: St. Helena, Napa County, *Jepson* in 1894 (G).

12b. LEPIDIUM VIRGINICUM var. PUBESCENS (Greene) comb. nov.

L. intermedium var. *pubescens* Greene, Bot. Gaz. 5: 157. 1881.

L. medium var. *pubescens* (Greene) Robinson, Gray, Syn. Fl. N. Amer. 1[1]: 127. 1895.

L. virginicum subsp. *texanum* (Buckl.) Thell. Monog. Lepid. 224, 229. 1906, in part (not *L. texanum* Buckley).

L. virginicum subsp. *texanum* var. *pubescens* (Greene) Thell. Monog. Lepid. 224, 230. 1906.

L. Menziesii DC. Syst. 2: 539. 1821. (See discussion below.)

L. virginicum subsp. *Menziesii* (DC.) Thell. Monog. Lepid. 225, 230. 1906, in large part.

L. occidentale Howell, Erythea 3: 32. 1895, based on a collection which has flowers with four stamens, a condition which is not particularly unusual: Umpqua Valley, Oregon, May 2, 1887, *Howell.*

L. bernardinum Abrams, Bull. Torr. Bot. Club 37: 149. 1910. Type, *Abrams 2826,* from Bear Valley, a representative plant for the variety as it occurs in southern California.

L. hirsutum Rydberg, Bull. Torr. Bot. Club 39: 322. 1912. A name substituted for *L. medium* var. *pubescens* Greene, as a species.

L. virginicum subsp. *centrali-americanum* var. *canescens* Thell. Monog. Lepid. 231. 1906. The type (Bear Mountains, Grant County, New Mexico, *Metcalfe 168*) is good average material of this variety and cannot be given recognition.

L. virginicum subsp. *eu-virginicum* var. *pubescens* Schmitz, Thell. Monog. Lepid. 229. 1906. ex. char. The type, *Heller 1495,* collected in southern Texas in 1894, has not been seen.

Plants usually tall and sturdy, the cauline leaves toothed to entire, often almost hispid; cotyledons oblique.

Western Colorado, New Mexico, Utah, Arizona, southern Nevada and throughout California; much less common in western Wyoming, southern Montana, Idaho, and coastal Oregon and Washington.

Representative material. NEW MEXICO: Winsor's Ranch, San Miguel County, *Standley 4534* (CA, G, MBG); Mangas Springs, Grant County, *Greene 102,* type collection (G); Bear Mountains, Grant County, *Metcalfe 168,* type collection *L. virginicum* subsp. *centrali-americanum* var. *canescens* Thell. (MBG, W). ARIZONA: vicinity of Prescott, *Wolf 2324* (CA, S), plants with

pubescent fruits; Flagstaff, *Hanson A100* (MBG, NY, W). Nevada: Charleston Mountains, *Hitchcock* in 1927 (P), *Jaeger* in 1926, with pubescent fruits (P). Utah: Hidden Lake, near Glendale, Kane County, *Jones 25334* (CA, MBG, P); Uintah Mountains, Summit County, *Payson & Payson 4858* (MBG, W). Colorado: Ridgway, Ouray County, *Payson & Payson 3837* (G, W). Wyoming: east of Afton, Lincoln County, *Payson & Armstrong 3320* (G, I, MBG, P, PA, W); Alpine, *Payson & Armstrong 3392* (G, I, MBG, P, PA, W). Montana: west Yellowstone, Gallatin County, *Payson & Payson 1922* (CA, G, MBG, NY, W). Idaho: Bear Creek, below Parker Mountain, Custer County, *Macbride & Payson 3308* (C, G, MBG, S, W, but not CA nor P). Washington: California, "A.M.", probably from vicinity of Seattle or Victoria, photograph of the type of *L. Menziesii* (US). Oregon: Portland, *Sheldon S10547* (G, MBG, NY, P, WSC). California: Truckee, *Heller 7090* (C, CA, F, G, MBG, S, W); White Mountains, Inyo County, *Duran 537* (C, CA, F, MBG, P, S, W); Bear Valley, San Bernardino County, *Abrams 2826*, type collection of *L. bernardinum* (C, F, G, MBG, NY, P, PA, US), *Hitchcock 2812* (M); Fallbrook, San Diego County, *Jones 2639* (CA, MBG, P). British Columbia: Campbell River, Vancouver Island, *Howell 7595* (CA); Nanaimo, *Eastwood 9767* (CA).

On the north Pacific Coast var. *pubescens* appears to intergrade with var. *medium*, since plants from that region vary greatly in the amount of pubescence present. As examples of such plants, may be cited: British Columbia: vicinity of Victoria, *Macoun 78237 & 78238* (F, NY), Sidney, *Macoun 91908* (NY). Washington: Olympic Mountains, *Elmer 2697* (MBG, NY, S, WSC); San Juan Island, *Zeller & Zeller 938* (G, MBG, NY), *Peck 13142* (MBG, WSC).

It must be admitted that the disposition of the western varieties of *L. virginicum* may be open to criticism. However, it is through var. *pubescens* that the close relationship of these western plants to the eastern ones is made evident, the only constant difference being that of the cotyledons.

Through the careful work of J. T. Howell, who examined the Menzies type at the British Museum, the identity of *L. Menziesii* is fairly definitely ascertained. It is certain that it belongs to the *L. virginicum* group, as the fruits match material of that species, *Eastwood 9767*, quite closely; the fact that the stem and inflorescence are "finely cinereous-puberulent" makes it fairly certain that it belongs to this pubescent variety, although Mr. Howell considers the pubescence a little more dense on the Menzies plant than on the Eastwood collection. However, the former plant has pubescent silicles, a condition seen in only two collections of *L. virginicum*, neither of which came from the northwest. Because of this fact, the possibility that *L. Menziesii* might be the same as some of the pubescent-fruited plants of *L. densiflorum* suggested itself, but several collections of such material were sent to Mr. Howell, who ventured the opinion that such could not be the case, as the fruits were entirely different in shape, the plants had a different aspect, and, of course, lacked the conspicuous petals of the type.

Although var. *pubescens* shows considerable variation in pubescence and in the amount of division of the leaves, one can find plants from southern California with the basal leaves as much dissected as are those of plants from Oregon, Washington, or New Mexico.

12c. Lepidium virginicum var. Robinsonii (Thell.) comb. nov.

L. Robinsonii Thell. Monog. Lepid. 255. 1906, based apparently upon *Jones 3050,* from San Diego, but all three collections cited agree quite closely.

L. californicum Nutt.; Torr. and Gray, Fl. N. Am. 1: 115. 1838, not *L. virginicum* var. *californicum* Jepson, Man. Fl. Pl. Calif. 439. 1925, based upon *Jepson 6623,* from Barstow, California, which is apparently either *L. virginicum* var. *medium* or *L. lasiocarpum* var. *georginum.* I have been unable as yet to see this type.

A rather small form, usually less than 2 dm. tall, densely hirtellous; cauline leaves often deeply lobed into narrow segments; cotyledons from slightly oblique to incumbent.

On the mainland and islands of coastal southern California; south into Lower California.

Representative material. California: Santa Barbara, *Nuttall,* type collection *L. californicum* (NY); Santa Cruz Island, *Hoffmann 654* (P), *Howell 6296* (CA); Los Angeles, *Grant 3469* (NY); San Gabriel Mountains, *Howell 3337* (CA); near Riverside, *Hall 3795* (W); near Corona, *Munz & Harwood 3399* (C, P, S, W); Santa Ana Canyon, *Howell 2559* (CA); San Diego County, near Bernardo, *Abrams 3365* (F, MBG, NY, P, S), Campo, *Eastwood 9452* (CA), Potrero Grade, *Munz 9494* (P), Point Loma, *Orcutt 1039* (MBG), San Diego, *Jones 3050,* type collection of *L. Robinsonii* (CA, MBG, I, NY, US, WSC, but not one sheet at CA, and sheet at P).

The relationship of these plants is plainly close to var. *pubescens,* although the cotyledons are less oblique than in that variety. It should be noted that although Thellung cited *Jones 3050* first in describing *L. Robinsonii,* that collection consists of two distinct species, and it is only by checking with the description and with the other two collections cited, namely, *Orcutt 1039* and *Hall 3795,* that it can be seen that he was concerned with plants of the *L. virginicum* group.

12d. Lepidium virginicum var. medium (Greene) comb. nov.

L. medium Greene, Erythea 3: 36. 1895.

L. intermedium Gray, Pl. Wright. 2: 15. 1853, not *L. intermedium* Richard, Fl. Abyssin. 1: 21. 1847.

L. idahoense Heller, Bull. Torr. Bot. Club 26: 312. 1899. *Heller & Heller 3044,* the type collection, is good representative material of the variety as here considered.

L. glaucum Greene, Pittonia 4: 312. 1901, based upon Cockerell's collection from Mesilla Park, New Mexico, in 1900. The type is merely a depauperate specimen of this glabrous variety.

Stems and pedicels glabrous or essentially so; cotyledons oblique to nearly incumbent; fruits mostly 2.5 mm. long or more.

Western Oklahoma, Rocky Mountains from southwestern Texas to Arizona, Colorado, and southern Wyoming; western Idaho, Washington, Oregon, south into northern California.

Representative material. OKLAHOMA: Fort Sill, Comanche County, *Clemens 11590* (CA, MBG, W). TEXAS: Alpine, *Jones 25836* (CA, MBG, P). NEW MEXICO: Mesilla Park, *Cockerell* in 1900, type collection *L. glaucum* (NY); Organ Mountains, *Wright 1320*, (G type), *Wooton* in 1899 (P, W); Mangas Springs, *Metcalfe 21* (C, G, MBG, P, S, W). ARIZONA: Tucson and vicinity, *Pringle* in 1884 (CA), *Eastwood 8158* (CA). COLORADO: Durango, *Eastwood 5342* (CA); Livermore, *Payson & Payson 4244* (MBG, W). WYOMING: Fish Creek, Albany County, *Payson & Payson 2509* (F, G, MBG, P, PA, W). IDAHO: near Lewiston, *Heller & Heller 3044*, type collection *L. idahoense* (C, MBG, NY, PA, S, US), *Sandberg, MacDougal & Heller 145* (CA, F, G, MBG, NY, P, S). WASHINGTON: near Asotin, *Hitchcock, Samuel & Crisafulli 2540* (CA, M, P, S, W, WSC); Klickitat County, *Suksdorf 2362* (F, G, MBG, S, WSC), *7833* (WSC); Wawawai, *Piper 3811* (G). OREGON: Portland, *Sheldon S10632* (G, MBG, P, WSC); near Roseburg, *Howell 1486* (C, MBG, WSC). CALIFORNIA: Hoopa Valley, Humboldt County, *Rattan* in 1878 (G).

In general aspect, material from Idaho and Washington seems to differ from plants of New Mexico, due chiefly to the more branching habit of the latter. However, this it not a constant difference, and indeed, there do not appear to be any good diagnostic characters by which they can be separated. As evidence of the great similarity of plants from the two areas it should be noted that *Suksdorf 7833* is as near a perfect match for Wooton's collection of 1899 from the Organ Mountains, New Mexico, as may reasonably be expected to exist.

12e. LEPIDIUM VIRGINICUM var. MEDIUM f. **pusillum** f. nov.

Upper portion of stems glabrous; cotyledons practically incumbent; fruits 2.25 mm. long or less. (Caulis glaber; embryo fere notorrhizus; silicula 2–2.25 mm. longa).

Type: New Braunfels, Comal County, Texas, May, 1850, *Lindheimer 462* (MBG). Collection also at Gray Herbarium.

Extreme southwestern Texas and New Mexico.

Representative material. TEXAS: without locality, *Lindheimer 671* (C, F, G, MBG); Keechi, Leon County, *Palmer 13421* (US); Austin, *Wright* in 1848 (G); near Holland, Bell County, *Wolff 791a* (US); Granbury, Hood County, *Eggert* (MBG); Mission, *Hanson 325* (MBG); Laredo, *Reverchon 3722, 3721* (MBG); Uvalde, *Palmer 11340* (MBG). NEW MEXICO: Organ Mountains, *Wright 1326* (MBG, PA), approaching var. *medium*.

13. LEPIDIUM SORDIDUM Gray, Pl. Wright. 1: 10. 1852.

L. granulare Rose, Contrib. U. S. Nat. Herb. 8[4]: 294. 1905. The type, from Mexico City, *Pringle 8488*, is but a form with fruits slightly larger than usual.

L. ruderale var. *lasiocarpum* Engelm.; Gray, Pl. Wright. 1: 15. 1852, based on *Lindheimer 459* and *460*.

Annual or biennial, 1–3.5 dm. tall, spreading to erect, granular-puberulent with clavate or flattened hairs; basal leaves spatulate-oblanceolate, 5–7 cm. long, *ca.* 2 cm. broad, pinnate-pinnatifid and lobed, the ultimate divisions linear, cauline leaves smaller, but pinnate-pinnatifid to pinnatifid with linear-lobed divisions; racemes numerous, crowded, 2–3 cm. long; pedicels about equal

to, or more commonly, slightly longer than fruit, erect or spreading, slender; sepals 0.5–0.8 mm. long, pilose; petals wanting or linear and minute; stamens 2 (4); silicles ovate to ovate-elliptic, 1.5–2.2 mm. long, glabrous, slightly winged at apex, sinus *ca.* one-tenth the length of fruit; style nearly equal to sinus, stigma about equalling apices of fruit; cotyledons incumbent. (Plate XIV, fig. 5.)

Extreme southwestern Texas; extending into Chihuahua and Federal District, Mexico.

Material seen. TEXAS: without locality, *Buckley* in 1882 (NY); expedition from western Texas to El Paso, May–Oct. 1849, *Wright 18,* type collection (G type, US); Rio Grande, *Havard 217* (G); Musquez Canyon, *Havard* in 1883 (US); Alpine Creek, Brewster County, *Cory 1606* (G); Alpine, *Palmer 30575* (MBG, NY, PA); Davis Mountains, *Young* in 1914 (G, MBG); 15 mi. north of Fort Davis, *Palmer 31017* (MBG); Fort Davis, *Eggleston 17403* (NY), *Ferris & Duncan 2710* (CA, NY, MBG, S).

14. LEPIDIUM AUSTRINUM Small, Fl. Southeastern U. S. 468, 1331. 1903.

L. lasiocarpum var. *tenuipes* Wats. Proc. Am. Acad. 17: 322. 1882, in small part (includes *Berlandier 2488*).

An erect, somewhat strict annual (biennial?) 1–5 dm. tall, densely hirsute throughout, usually simple below; basal leaves spatulate-oblanceolate, 5–9 cm. long, 1–2 cm. broad, divided to pinnate, the divisions oval to obovate, serrate-dentate, or lobed, cauline leaves smaller, averaging 0.7–1 cm. broad below branches, serrate-dentate, those of inflorescence narrowly oblanceolate, less than 0.5 cm. broad, serrate or entire; racemes 5–20 cm. long in fruit; pedicels 2.5–5 mm. long in fruit, spreading to slightly recurved, slender, somewhat flattened, usually glabrous on lower side and short-hirsute above; sepals slightly less than 1 mm. long, pilose-hirsute on back; petals sometimes lacking, but usually present, minute to slightly longer than sepals; stamens 2; silicles ovate to elliptic-obovate, 2.25–3 mm. long, slightly less in width, with narrow winged apex, the sinus shallow (*ca.* one-eighth length of fruit), both surfaces usually conspicuously hirsute with slightly appressed hairs, in some cases margin only pubescent; cotyledons incumbent. (Plate XV, fig. 4.)

Central and southwestern Texas, Mexico.

Representative material. Without definite locality, *Berlandier 2488* (NY, PA). TEXAS: Peña Colorado, *Havard 74* (G, US) with some doubt; Dallas, *Reverchon 2726* (G, MBG), *Reverchon 2198, 2199,* and *2200* (MBG), *Bush 583* and *633* (NY); Roosevelt, *Jones 28081* (C, MBG, P); San Marcos, *Palmer 12113* (C, MBG, W); New Braunfels, *Lindheimer 459* (MBG), *460* (MBG, PA), *672* (C, F, G, MBG, NY, PA), *673* (F, G, NY); Wharton, *Palmer 4972* (F, MBG, US); Experiment Station, Sonora, *Jones 28083* (C, CA, MBG, P); Kerrville, *Heller 1651,* type collection (C, F, G, MBG, NY type, US, W, WSC).

Very similar, in some respects, to *L. lasiocarpum* (especially var. *tenuipes* from Mexico) but differing in the following char-

acters:— leaves, especially the cauline, usually wider and more entire; plants more erect and strict; pubescence more hirsute than hispid; pedicels longer and more slender; fruits smaller, in shape resembling those of *L. virginicum* more than those of *L. lasiocarpum;* hairs on the fruits somewhat appressed, especially at the apex, whereas they are more spreading in *L. lasiocarpum.*

15. Lepidium lasiocarpum Nutt.; Torr. and Gray, Fl. N. Am. 1: 115. 1838.

Annual, 0.5–3 dm. tall, prostrate to erect, moderately pubescent to densely hirsute, hispid, or hirsute-hispid; leaves linear to oblanceolate, varying greatly in size, 1–6 cm. long, 0.2–1.5 cm. broad, basal lobed to pinnate-pinnatifid, cauline entire to pinnatifid; racemes 3–8 cm. long; pedicels distinctly flattened on upper and lower sides, two to several times as broad as thick, 1.5–4 (5) mm. long, ascending to spreading; sepals *ca.* 1 mm. long; petals spatulate to linear (lacking), usually no longer than sepals; stamens 2 (4); silicles from oval to elliptic, rotund, or oblong-obovate, 3–4.5 mm. long, 2.25–4 mm. broad, hirsute-hispid on both surfaces to short hispid on margins only, or even glabrous, finely reticulate, apex winged, the sinus one-tenth to one-fifth the length of the fruit, narrow to fairly open; style lacking or essentially so; cotyledons incumbent. (Plate XVII, fig. 2.)

Besides the following varieties which have been recognized, note should be made of two tendencies within the group which are of interest. Plants from Palm Springs and the upper Coachella Valley, California, often have fruits very much like those of *L. dictyotum.* These plants which are usually small with narrow leaves have been reported by some collectors as *L. dictyotum.* Some of the collections from the islands off the coast of Southern California, and from the vicinity of La Jolla, California, consist of plants with larger fruits and larger, more divided leaves than those of any form except var. *Wrightii.*

Key to Varieties of L. lasiocarpum

Plant densely hispid; cauline leaves lobed to pinnatifid; hairs on fruits with pustular bases .... 15a. *L. lasiocarpum* var. *Wrightii*

Plant hirsute or hirtellous-hispid; cauline leaves more nearly entire, but if lobed or divided, the fruits not pustular-hispid.

  Fruits nearly rotund or even rotund-obovate, 4 mm. long and fully as broad .... 15b. *L. lasiocarpum* var. *rotundum*

  Fruits usually longer than broad, but if rotund, less than 4 mm. broad.

    Stems glabrous to pubescent, not hirsute-hispid; pedicels usually glabrous on lower side; plants usually simple or with but 2 or 3 branches from base .... 15d. *L. lasiocarpum* var. *georginum*

Stems hirsute-hispid; pedicels usually pubescent on lower side; plants mostly several-branched from base . . . . 15c. *L. lasiocarpum* var. *typicum*

15a. Lepidium lasiocarpum var. **Wrightii** (Gray) comb. nov.

L. Wrightii Gray, Pl. Wright. 2: 15. 1853.

L. lasiocarpum subsp. *Wrightii* Thell. Monog. Lepid. 266. 1906, in large part.

L. Nelsonii Williams, Bull. Torr. Bot. Club 61: 259. 1934, based on *Nelson 11417*, from Frijoles, New Mexico, which is a slightly more ascending plant than usual, but otherwise typical var. *Wrightii*.

Whole plant hispid, the hairs usually with pustular bases; pedicels much broadened; leaves all lobed to pinnate.

Extreme southwestern Texas, southern and central New Mexico, southeastern Arizona, and adjacent Mexico.

Representative material. Texas: near Kent, *Earle & Tracy 391* (NY); Laredo, *Reverchon 3723* (G, MBG, US); Carrizo Springs, Dimmit County, *Palmer 33752* (MBG, NY); El Paso, *Thurber 152* (G, NY), *Jones 3781* (F, NY, P). New Mexico: without locality, *Palmer 560* (C); near Frijoles, *Nelson 11417*, type collection of *L. Nelsonii* (C, W type); Valley of the Pecos, *Wright 341* (G), *Wright 855*, (C, G type, MBG, NY, US); Carlsbad Caverns, *Nelson 11392* (C, MBG, S, W); Mesilla Valley, *Wooton & Standley* in 1907 (F, M, MBG, NY, S). Arizona: near Camp Lowell, *Pringle 13622* (MBG); Tucson and vicinity, *Griffiths 2438* (NY), *Greene 5* (G); Sacaton, *Harrison & Kearney 8385* (US); Williams River, *Bigelow* in 1853–54 (NY). Much of the material from southern Arizona is somewhat intermediate between var. *Wrightii* and var. *typicum*. As examples of such plants the following are typical: Marana to Red Rock, Pinal County, *Gillespie 8891* (C, NY, S); Bowie, Cochise County, *Eastwood 8613* (CA).

15b. Lepidium lasiocarpum var. **rotundum** var. nov.

Plants hirsute-hispid; cauline leaves divided to entire; pedicels much flattened, nearly glabrous; fruits nearly rotund, *ca.* 4 mm. long, glabrous except for few short marginal hairs . (Planta hirsuto-hispida; foliis caulinis divisis vel integerrimis; pedicellis compressissimis, fere glabris; silicula fere rotunda, ca. 4 mm. longa, pubescente-marginata.) (Plate XVII, fig. 2b.)

Type: Corpus Christi at Causeway, Texas, March 16, 1929, *Tharp 5576*, United States National Herbarium, no. 1468782.

Representative material. Texas: Padre Island, *Tharp 5578* (US); Boca Chica, near coast, *Runyon 1394* (US).

The large round fruits of these plants are different from all others of *L. lasiocarpum*. The variety is undoubtedly most closely related to var. *Wrightii*, which it resembles in habit and leaf character, but the leaves and stems are much less hispid, and the fruits are nearly glabrous.

15c. Lepidium lasiocarpum var. **typicum** nom. nov.

L. lasiocarpum Nutt.; Torr. and Gray, Fl. N. Am. 1: 115. 1838.

L. lasiophyllum Brandegee, Proc. Calif. Acad. ser. 2, 1: 207. 1889 (erratum).

L. lasiocarpum subsp. *Wrightii* Thell. Monog. Lepid. 266, in part.

L. lasiocarpum subsp. *Wrightii* var. *pubescens* Thell. Monog. Lepid. 267. 1906, based on *Shockley 9,* from Candelaria, Nevada, a plant that is well within the range of variation of var. *typicum.*

L. Palmeri Wats. Proc. Am. Acad. 24: 39. 1889, based on *Palmer 560,* from Los Angeles Bay, Lower California, agrees quite well with material of var. *typicum* from the coastal region of southern California.

L. lasiocarpum subsp. *Palmeri* (Wats.) Thell. Monog. Lepid. 267. 1906.

Plants hispid, the hairs without pustular bases; fruits from nearly glabrous to quite hispid; leaves variable; pedicels much flattened, usually shorter than fruits and more than twice as broad as thick. (Plate XVII, figs. 2, 2a.)

Southwestern Colorado through southern Utah and Arizona to central and southern Nevada, Mohave and Colorado Deserts and coastal southern California south into Mexico.

Representative material. COLORADO: Naturita, Montrose County, *Payson 264* (F, G, MBG, W). UTAH: La Verkin, *Jones 5183c* (P). ARIZONA: Rodeo, *Jones 25838* (MBG, P); Scottsdale to Granite Reef, *Gillespie 5650* (C, NY, S); Canyon Lake, *Nelson 11213a* (C, MBG, W). NEVADA: Beaver Dam Wash, Lincoln County, *Goodding 2141* (W), approaching var. *georginum;* east of Sparks, *Eastwood & Howell 94* (CA, M); Goldfield, Esmeralda County, *Heller 9609* (NY, S); Candelaria, *Shockley 9,* type collection of *L. lasiocarpum* subsp. *Wrightii* var. *pubescens* (C, S), *Shockley 209* (G). CALIFORNIA: Panamint Mountains, *Coville & Funston 499* (G, NY); Red Rock Canyon, Kern County, *Howell 4940A* (CA); Providence Mountains, *Munz & Harwood 3441* (P, W); Mecca, *Spencer 1758* (G, P); Santa Barbara, *Nuttall,* (G type, PA); Hueneme Beach, *Munz 9394* (C, P); Ballona Harbor, Los Angeles County, *Abrams 1182* (MBG, P, S); Calexico, *Abrams 3148* (C, F, G, MBG, NY, P, S); San Diego River, *Abrams 3407* (F, G, MBG, NY, P, PA, S). LOWER CALIFORNIA: Los Angeles Bay, *Palmer 560,* type collection of *L. Palmeri* (G type, US). WASHINGTON: without locality, *Vasey 176* (US), possibly an error in labels.

The following collections are examples of the plants with fruits resembling those of *L. dictyotum* although they are not considered sufficiently different to be given nomenclatural recognition: ARIZONA: Oatman, Mohave County, *Harrison & Kearney 7581* (US). CALIFORNIA: Kelso, Mohave Desert, *Jones* in 1906 (P); Palm Springs, *Eastwood 3052* (CA), *Spencer 764* (G, NY, P), *Spencer 1486* (G, P); Magnesia Canyon, *Munz 12006* (C, M, MBG, P); Painted Canyon, *Howell 3540* (CA); 2 miles north of Cargo Muchacho Mountains, Imperial County, *Munz & Hitchcock 12151* (M, MBG, P); San Felipe Creek, San Diego County, *Eastwood 2813a* (CA); Mountain Palm Spring, eastern San Diego County, *Munz & Hitchcock 12101* (C, M, MBG, P). The next four collections are typical of the peculiar form found on the coastal islands which resembles var. *Wrightii* in general habit: Costa Mesa, Orange County, *Munz 12191* (M, MBG, P, S); La Jolla, *Clements & Clements 28* (G, I, MBG, NY, PA), mixed with some *L. nitidum;* San Clemente Island, *Munz 6609* (C, G, P); San Nicolas Island, *Trask* in 1901 (G). Where the ranges of var. *typicum* and var. *georginum* overlap there is marked intergradation of the two, as exemplified by the following collection: UTAH: St. George, *Jones 5110f* (P). ARIZONA: Hermit Creek, Grand Canyon, *Eastwood 5959* (CA). CALIFORNIA: Inyo County,

Black Canyon, White Mountains, *Duran 740* (C, CA, MBG, NY, W); Panamint Mountains, *Hall & Chandler 6954* (P), *Coville & Funston 520* (MBG); Chuckwalla Mountains, *Munz & Keck 4905* (P); Borrego Springs, Colorado Desert, *Jones* in 1906 (P).

15d. Lepidium lasiocarpum var. **georginum** (Rydberg) comb. nov.

L. georginum Rydberg, Bull. Torr. Bot. Club 30: 253. 1903.

L. lasiocarpum subsp. *georginum* Thell. Monog. Lepid. 267. 1906.

Plants much less harshly pubescent than other varieties, the stems sometimes glabrous or nearly so, usually unbranched at base; cauline leaves entire or toothed; pedicels glabrous on lower side; fruits as in var. *typicum,* but usually glabrous on lower side.

Southern Nevada and adjacent California, Arizona, and Utah.

Representative material. Utah: Gold Hill, Tooele County, *Jones* in 1891 (P); St. George, *Palmer 41* (NY); valley of Virgin, near St. George, *Parry 19* (F, G, MBG, NY type); La Verkin, *Jones 5185* (MBG, NY, P). Nevada: Snow Springs, *Goodding 2157* (G, W); Calientes, *Goodding 913* (F, MBG, NY, W); Moapa, *Goodding 2186* (C, G, MBG, W); Las Vegas, *Tidestrom 8609* (F, MBG); Reno, *Jones 3786* (CA, I, MBG, NY, P). California: White Mountains, Inyo County, *Heller 8215* (CA, F, G, MBG, NY, S); Chuckwalla Valley, Riverside County, *Munz & Keck 4806* (P); White Tanks, Riverside County, *Munz & Hitchcock 12227* (C, M, MBG, P). Arizona: Littlefield, Mohave County, *Jones* in 1926 (P, S) intermediate between var. *georginum* and var. *Wrightii.*

16. Lepidium nitidum Nutt.; Torr. and Gray, Fl. N. Am. 1: 116. 1838.

Annual, erect to spreading, 0.5–4.5 dm. tall, puberulent or pubescent near inflorescence, pubescent to glabrous below; basal leaves 3–10 cm. long, deeply pinnatifid, the 3–7 pairs of segments about as wide as rachis, entire or toothed, cauline leaves smaller, pinnatifid to entire, sometimes as much as 3–4 mm. broad; racemes in fruit rather loose, many-flowered; pedicels densely puberulent, very much flattened; sepals ovate, *ca.* 1 mm. long, villose to glabrous on back, often purplish; petals spatulate, 1–1.5 mm. long, or minute; stamens usually 6, the shorter sometimes vestigial or lacking; fruits ovate or ovate-elliptic to nearly orbicular, usually glabrous but sometimes with the margins minutely pubescent, nerves not prominent, the surfaces smooth and shining, convex below, somewhat concave above, the margins upturned, *ca.* 4 (2.5–6) mm. long, 3.5 (2.5–5) mm. broad, the apex with notch 0.2–0.5 mm. deep, the sinus usually very narrow, but sometimes moderately open; style lacking or essentially so; cotyledons incumbent. (Plate XV, fig. 6.)

Key to Varieties of L. nitidum

Silicles with distinct divergent apices prolonged beyond the general oval contour of the fruits .... 16b. *L. nitidum* var. *oreganum*

Silicles with apices parallel or slightly divergent, but never distinctly prolonged beyond the contour of the fruit.
  Stems densely pubescent, almost cinereous; fruits minutely pubescent on margins .... 16c. *L. nitidum* var. *Howellii*
  Stems glabrous to fairly densely pubescent, but not cinereous; fruits glabrous .... 16a. *L. nitidum* var. *typicum*

16a. Lepidium nitidum var. typicum comb. nov.

L. nitidum Nutt.; Torr. and Gray, Fl. N. Am. 1: 116, 668. 1838.

L. leiocarpum Hook. and Arn. Bot. Beech. 324. 1840. The original description and the type collection by Douglas leave no doubt that this is synonymous with *L. nitidum.*

L. nitidum var. *insigne* Greene, Fl. Franciscana 274. 1891. This is merely a large fruited specimen; plants of this nature are fairly common, but there appears to be no particular region where they are constant.

Silicles without distinct divergent apices, 3.5–6 mm. long, glabrous; stems glabrous to moderately pubescent.

Klickitat County, Washington, southwestern Oregon, fairly common throughout California at lower altitudes except in the desert region; into Lower California.

Representative material. Washington: Rockland, *Suksdorf 845* (C, F, MBG, WSC). Oregon: near Selma, *Henderson 5728* (CA, MBG, W); Umpqua Valley, *Howell* in 1881 (F, NY). California: without definite locality, *Douglas,* type collection *L. leiocarpum* (G), *Nuttall,* part of type collection? (G); Cherokee Mine, Butte County, *Heller 13096* (CA, F, G, I, MBG, PA); Marysville, Sutter County, *Heller 7562* (F, G, MBG, NY, PA, S); near Santa Rosa, *Heller & Brown 5054* (F, G, I, MBG, NY, P, PA, S, W); Byron Springs, Contra Costa County, *Eastwood 3775* (CA, G, NY); Stanford University, *Baker 310* (C, F, G, MBG, NY, P, S, W, WSC); 3 miles south of Blackwell's Corner, Kern County, *Howell 5897* (CA); Santa Barbara, *Nuttall* (G type, NY); east side Santa Rosa Island, *Munz & Crow 11698* (P); Avalon, Santa Catalina Island, *Trask* in 1901 (MBG, NY); Pasadena, *Jones 3036* (CA, I, MBG, NY, P); San Bernardino, *Parish & Parish 47* (F, G, MBG); San Clemente Island, *Trask 347* (NY), San Diego, *Orcutt 23* (F, G, MBG). A collection from near San Bernardo, Monterey County, *Howell 5990* (CA, M) approaches var. *Howellii.* Texas: North Comanche, *Eggert* in 1900 (MBG) (introduced).

Large fruited specimens, called var. *insigne* by Greene, are exemplified by the following collections: north base of Tehachapi Pass, Kern County, *Munz 8973* (P); north of Lebec, Kern County, *Jones* in 1921 (P); 8 miles north of Oroville, Butte County, *Heller 11177* (C, CA, F, G, I, MBG, NY, PA).

Another variation in fruit size that appears to be a more constant condition is found in material from southern California, particularly from Point Loma and from Claremont, for example: Claremont, *Munz 2070, 11061* (P); sea cliffs, Point Loma, San Diego County, *Bartram 476* (PA), *Eastwood 2536* (CA, G). In these collections, and on other plants from the same localities,

the fruits are only about 2.5 mm. in length. However, because of the great variation in fruit size in this species, these plants are not being proposed as a new entity.

16b. Lepidium nitidum var. **oreganum** (Howell ex Greene) comb. nov.

L. oreganum Howell; Greene, Fl. Franciscana 274. 1891, in part.

L. oreganum Howell, Pac. Coast Pl. Coll. of 1887, without description.

L. strictum var. *oreganum* Robinson, Gray Syn. Fl. N. Am. 1[1]: 129. 1895.

Fruits 3.5 mm. long or longer, with distinct acute divergent apices; stems glabrous or inconspicuously pubescent.

Southern Oregon and California; wherever the ranges of *L. nitidum* and *L. dictyotum* overlap.

Representative material. Oregon: Rogue River Valley, Josephine County, *Howell 627* (G), *Howell* in 1887, type collection (F, MBG, NY, US, WSC). California: Hornbrook, Siskiyou County, *Smith* in 1913 (CA); Woodland, Yolo County, *Blankinship* in 1893 (G); Byron Springs, Contra Costa County, *Eastwood 3766a* (CA); Stockton, *Stanford 110* (W); near Tracy, *Howell 5784* (CA, F, M); 15 miles southeast of Merced, *Howell 4113* (CA); 3 miles east of Los Banos, *Abrams 10752* (P); 1–5 miles southeast of San Benito, *Howell 6018* (CA, M, P); 6 miles southeast of Stratford, Kings County, *Howell 5792* (CA, M); Cholame, San Luis Obispo County, *Eastwood & Howell 2010* (CA).

As Mr. J. T. Howell (Leafl. West. Bot. 1: 92. 1934) has so well shown, these plants are intermediate in character between *L. nitidum* and the *L. latipes-L. dictyotum-L. oxycarpum* complex. They are found only where the ranges of *L. nitidum* and *L. dictyotum* overlap, and Mr. Howell has been successful in finding these two species growing nearby whenever he has found the plants of suspected hybrid nature (var. *oreganum*). Because they are so much more similar to *L. nitidum* than to *L. dictyotum*, they are here assigned varietal rank as indicated until such time as they may be proved to be of hybrid origin.

16c. Lepidium nitidum var. **Howellii** var. nov.

Fruits 3.5–5 mm. long, without divergent acute apices, usually with minutely pubescent margins; stems densely pubescent, almost cinereous; racemes numerous, dense. (Silicula 3.5–5 mm. longa, sine apicibus acutis divergentibus, margine pubescente; caulibus pubescentissimis, fere cinereis; racemis numerosis, densis).

Type: Near Mohave, Kern County, April 24, 1905, *Heller 7760* (C, type; also F, G, MBG, NY, PA).

Mohave Desert of eastern Kern County and adjacent San Bernardino County, California.

Material seen. 5 miles northeast of Kramer, San Bernardino County, *Craig, Newsom, & Hilend 115* (P); 5 miles south of Mohave, Kern County, *Munz*

10082 (P); near Mohave, *Johnston* in 1920 (P), 8 miles west of Ricardo, *Howell 4995* (CA, M); 35 miles west of Wasco, *Munz 10104* (P), approaching var. *typicum.*

That the writer was not the first to notice the distinctive character of these plants is shown by the labels of the plants collected by J. T. Howell, which bear the identification "L. nitidum var.?" The dense pubescence of the stems, the densely crowded racemes, and the ciliate-margined fruits would seem to indicate that these plants are more than chance ecological variants.

17. Lepidium dictyotum Gray, Proc. Am. Acad. 7: 329. 1868.

A low densely pubescent annual 2–14 (20) cm. tall, somewhat spreading; basal leaves usually pinnatifid with 2–5 pairs of linear lobes, these sometimes cleft, the rachis and lobes 1–1.5 (2.5) mm. broad, cauline leaves mostly entire, 1–2.5 mm. broad; racemes various, many-flowered, usually lax and equal to, or longer than, rest of stem, or sometimes quite compacted; pedicels 1.5–3.5 mm. long, flattened, sometimes reflexed, but never truly sigmoid; sepals 0.75–1 mm. long, pubescent on back; petals usually lacking or sometimes as much as 1.25 mm. long; stamens 4 (6); fruits 3.25–4.5 mm. long, 2.25 mm. broad, glabrous to hirtellous or densely hirsute when mature, prominently reticulate, typically ovate in outline, the apices sometimes prolonged considerably and then only the portion below stigma truly ovate, apex winged, prolonged 0.3–1 (2) mm. beyond stigma, the wings usually rounded and more or less parallel, or slightly divergent, but sometimes the apices acute or acuminate and divergent, sinus acute; style lacking; cotyledons incumbent. (Plate XVI, fig. 1.)

There is great variation in the species in nearly all characters, especially in the length of the apices of the fruit, in the angle of the sinus, and in the amount of pubescence on the silicles, as well as in the degree of compactness of the inflorescence and even in the general habit. J. T. Howell, in his field studies of the species, has made careful note of this variation, and several of his collections, such as no. 4111, were made to illustrate it. There is a tendency for some of the material, which has been named var. *acutidens,* to have much longer apices on the fruits than are found on most of the plants. Indeed, some of this material appears to be intermediate between *L. dictyotum* and *L. latipes,* whereas other plants appear to be intermediate between *L. dictyotum* and *L. oxycarpum.* The exact status of such material is not clear, but it may be separated as follows.

Key to Varieties of L. dictyotum

Winged apices of fruit less than 1 mm. long, usually rounded or obtuse to acute .... 17a. *L. dictyotum* var. *typicum*

Winged apices over 1 mm. long, acuminate .... 17b. *L. dictyotum* var. *acutidens*

17a. LEPIDIUM DICTYOTUM var. typicum nom. nov.

L. dictyotum Gray, Proc. Am. Acad. 7: 329. 1868.

L. dictyotum var. *macrocarpum* Thell. Monog. Lepid. 271. 1906. The type collection, from near Livermore, *Greene* in 1889, is not at all unusual; the fruits are scarcely 4 mm. long.

L. acutidens var. *microcarpum* Thell. Monog. Lepid. 271. 1906. The type, *Jones 3061* from San Diego, is really intermediate between var. *typicum* and var. *acutidens*, but surely cannot be given recognition.

Racemes usually quite compactly flowered; fruits mostly *ca.* 3.5 mm. long, the apices rounded or at most no more than acute, scarcely divergent. (Plate XVI, fig. 1.)

In alkaline soil; region of Great Salt Lake, Utah, Columbia River region of Idaho, south central Washington, inland Oregon, western Nevada, and fairly common at lower altitudes throughout California except in the true desert region.

Representative material. UTAH: Granger, Salt Lake County, *Garrett* in 1921 (NY). NEVADA: Carson City, *Watson 125* (G, NY); Empire City, *Jones 3787* (CA, MBG, NY, P). IDAHO: Weiser, *Jones 6154* (MBG, P, S); near Lewiston, *Heller & Heller 2991* (MBG, S, PA). WASHINGTON: near Sprague, *Sandberg & Leiberg 138* (C, F, G, NY, P); Rockland, *Suksdorf 844* (F, G, MBG, NY, WSC). OREGON: near Lexington, *Leiberg 1* (C, F, G, MBG, NY, P, PA, S, W); The Dalles, *Sheldon S10210* (G, MBG, NY, P, WSC). CALIFORNIA: east of Livermore, March 10, 1889, *Greene*, type collection of *L. dictyotum* var. *macrocarpum* (NY), *Howell 10872* (CA, NY); 5 miles east of Salinas Valley, Monterey County, *Howell 5979* (CA, M); 15 miles southwest of Merced, *Howell 4111* (CA, F, G, MBG, NY); Coalinga, *Eastwood 13463* (CA); Hanford, *Eastwood 3857* (CA, G, NY); near Bakersfield, *Heller 7594* (C, F, G, MBG, NY, PA, S); Mohave Desert, *Pringle* in 1882 (F, G, MBG, PA); San Bernardino, *Parish & Parish 794* (C, F, G, MBG, PA); Temecula, *Jones* in 1882 (NY, P). The following two collections approach var. *acutidens:* San Diego, March 14, 1882, *Jones 3061,* type collection *L. acutidens* var. *microcarpum* (CA, MBG, NY, P, PA, S, WSC); San Diego, *Cleveland* in 1882 (S). The species has been reported from the Coachella Valley, and several collections from that area labelled "*L. dictyotum,*" have been seen. This material is here referred to *L. lasiocarpum.*

17b. LEPIDIUM DICTYOTUM var. ACUTIDENS Gray, Proc. Am. Acad. 12: 54. 1877.

L. acutidens (Gray) Howell, Fl. Northwest Am. 1[1]: 64. 1897.

L. oxycarpum var. *acutidens* Jepson, Man. Fl. Pl. Cal. 441. 1925.

L. oreganum Howell; Greene, Fl. Franciscana 274. 1891, in large part, except for the Howell specimen.

Racemes from loosely to densely flowered; fruits mostly over 4 mm. long, with acuminate, divergent, winged apices mostly over 1 mm. long.

With var. *typicum* in Washington, Oregon, and California, but much less common. In California var. *acutidens* seems to range farther northward than does var. *typicum.*

Representative material. OREGON: Ashland, *Howell 3849* (NY). CALIFORNIA: without definite locality, *Kellogg & Harford 39* (CA, MBG, NY, S); near Yreka, *Greene 725* (F, G type, MBG); Colusa, *Heller 13542* (F, I, MBG, NY, S); Nortonville, *Rose 33041* (F, M, NY, P, S); lower San Joaquin, *Bioletti* in 1892 (C, G); near Livermore, *Howell 10873* (CA, F, MBG, S); Compton, *MacClatchie* in 1897 (CA); 1 mile south of Perris, Riverside County, *Howell 4783* (CA); San Diego, *Pringle* in 1882 (NY). Two collections from alkali flats, Umatilla, Oregon, *Howell*, May 8, 1882 (F, MBG, NY, S), and May 10, 1882 (NY, PA), have unusually large fruits and might easily be mistaken for *L. latipes*. The pubescence and reticulation of the fruits of this material are so similar to the corresponding features of the silicles of *L. dictyotum* that it seems the most logical treatment to include it here. The following series shows a continuous gradation from *L. dictyotum* var. *typicum* to the most extreme form of var. *acutidens*: *Howell 5979, Eastwood 13463, Jones 3061, Rose 33041, Kellogg & Harford 39, Bioletti* in 1892, *Greene 725*, and *Howell*, May 8 and 10, 1882.

18. LEPIDIUM OXYCARPUM Torr. and Gray, Fl. N. Am. 1: 116, 668. 1838.

Slender annual, erect to diffuse, 5–20 cm. tall, from glabrate to moderately pubescent; leaves 2–6 cm. long, the basal ones often with 2–4 pairs of linear lobes, rachis 1–3.5 mm. broad, cauline leaves usually linear, entire, 1–3 mm. broad; pedicels (at least on older fruits) 3–5 (2.5) mm. long, slender, reflexed or even somewhat sigmoid; sepals *ca.* 0.5 mm. long, all alike and ovate, or two of them narrower, sparsely pilose on back; petals *ca.* 0.5 mm. long, somewhat spatulate, or much reduced, frequently lacking; stamens usually 4, silicles finely reticulate, glabrous, ovate but with the apex widened because of the divergent wings, 2.5–3.5 mm. long, 2–2.5 mm. broad, the winged apices acute or acuminate, less than 1 mm. long, widely divergent, the sinus from barely acute to obtuse; style lacking; cotyledons incumbent. (Plate XVII, fig. 1.)

Saline soil chiefly in the San Francisco Bay region; also collected at Victoria, British Columbia.

Representative material. CALIFORNIA: without locality, *Douglas*, type collection (G, NY), *Coulter* (F, G, NY, PA); Woodland, Yolo County, *Blankinship* in 1893 (G); Vallejo, *Greene* in 1874 (G); Petaluma, *Howell 10924* (CA, P, S); 9 miles south of Sonoma, *Keck 996* (G, P, S); 4.5 miles north of San Rafael, Marin County, *Howell 10919* (CA, M, NY, P, S); Alameda County, *Michener & Bioletti* in 1893 (MBG, NY, P); San Francisco Bay, 4 miles west of Decoto, *Howell 4652* (CA, MBG, NY); Berkeley, *Greene* in 1881 (MBG, S); near Livermore, *Howell 10874* (CA, F, MBG); Alviso, Santa Clara County, *Bioletti* in 1892 (W); Redwood City, San Mateo County, *Keck 1401* (CA, CI, E, LW); 7 miles from Hollister on road to Gilroy, San Benito County, *Howell 11021* (CA). BRITISH COLUMBIA: vicinity of Victoria, *Macoun* in 1893 (G, MBG, NY, US).

In fruit character, *L. oxycarpum* is approached only by *L. dictyotum* var. *acutidens*. However, the fruit lacks pubescence in the former species, the sinus is more open and the winged apex is shorter. The pedicels are more slender, some of them nearly always being over 3 mm. long.

19. LEPIDIUM LATIPES Hook. Ic. Pl. 1: pl. 41. 1837.

L. Brownii Heller, Pl. Calif. 1902 . n. 5429 (without description). Racemes more elongate than normal, otherwise typical material.

L. Brownii Heller; Thell. Monog. Lepid. 267. 1906, in synonymy.

A low, spreading annual with branches 3–10 (25) cm. long, very densely pubescent to short canescent-hirsute; leaves as much as 14 cm. long, basal ones, at least, pinnatifid into 3–10 pairs of linear, entire or dissected divisions, the rachis and segments 1–6 mm. broad; racemes short, 2–5 (12) cm. long, very much congested, pedicels much widened and flattened, 2–3 mm. long, ascending; sepals oblong-ovate, *ca.* 1.25 mm. long, densely pubescent; petals oblong-obovate, 2–4 mm. long, quite pubescent on back, also ciliate-laciniate; stamens 4 (in specimens examined); silicles short-hirsute or hispidulous, oblong-ovate, 5.5–7 mm. long, *ca.* 3.5 mm. broad, with acute winged apices, *ca.* 2 mm. long, parallel, or slightly divergent, the sinus very narrow; cotyledons incumbent. (Plate XVI, fig. 2.)

Saline soil and vernal pools at lower elevations, Humboldt County to San Diego County, California.

Representative material. CALIFORNIA: without locality, *Douglas*, type collection (G, NY); Spruce Grove, near Harris, Humboldt County, *Tracy 1644* (C); Willows, Glenn County, *Eastwood 10215* (CA); 4 miles east of Williams, Colusa County, *Ferris 532* (MBG, NY, P, S); Dashiells, Mount Sanhedrin, Lake County, *Eastwood 12814* (CA); Petaluma, *Eastwood 10451* (CA); near Black's, Yolo County, *Heller & Brown 5429*, collection listed as *L. Brownii* (F, G, MBG, NY, P, PA, S, US, W); Camp 68, Martinez, *Brewer 985* (C, MBG, S, WSC); salt marshes, Alameda County, *Brandegee* in 1890 (G); Stockton, *Stanford 837* (G, P, S); French Flat, Tuolumne County, *Ferris 1555* (CA, NY); 10 miles northwest of Hollister, San Benito County, *Howell 11001* (CA); Carpenteria, Santa Barbara County, *Brewer 273* (C, G); Avalon, Santa Catalina Island, *Trask* in 1901 (MBG, NY); near Santa Monica, *Hasse* in 1891 (G, NY); San Diego, *Cleveland 794* (G), April 3, 1882, *Pringle* (F, NY, PA), April 26, 1882, *Pringle* (G, MBG), *Jones 3060* (CA, MBG, NY).

20. LEPIDIUM FLAVUM Torr. Pacif. R. R. Rep. 4: 67. 1857.

A glabrous, yellowish-green, prostrate or ascending annual, the branches 3–30 cm. long; basal leaves spatulate to oblong-lanceolate or lanceolate, 2–5 cm. long, rather irregularly lobed to pinnatifid, cauline more cuneate, somewhat smaller, the lobes less deep (leaves frequently entire or with somewhat serrate teeth on upper third only); flowers in crowded to comparatively loose racemes, sometimes quite densely crowded and seemingly capitate or umbellate; pedicels terete or but slightly flattened; flowers pale to bright sulfur-yellow; petals about 2 mm. long; stamens 6; silicles oval, 2–4 mm. long, 1.5–3.5 mm. broad, usually with distinct winged divergent apices, prominently reticulate, glabrous, but with scale-like projections arising mostly from the nerves; style 1–1.5 mm. long; cotyledons incumbent. (Plate XVI, fig. 3.)

KEY TO VARIETIES OF L. FLAVUM

Silicles 2–3 mm. long, 1.5–2.2 mm. broad; styles usually half the length of the fruit or more .... 20a. *L. flavum* var. ***typicum***

Silicles 3–4.5 mm. long, 3–3.5 mm. broad; styles not half so long as fruit .... 20b. *L. flavum* var. ***felipense***

20a. LEPIDIUM FLAVUM var. typicum nom. nov.

L. flavum Torr. Pacif. R. R. Rep. 4: 67. 1857.

Sprengeria flava (Torr.) Greene, Leaflets Bot. Obs. and Crit. 1: 198. 1906.

Sprengeria Watsoniana Greene, Leaflets Bot. Obs. and Crit. 1: 199. 1906. Type, *Watson 126;* see discussion of this and following synonyms below.

Sprengeria minuscula Greene, Leaflets Bot. Obs. and Crit. 1: 199. 1906. Type, *Coville & Funston 734.*

Lepidium flavum Torr. var. *apterum* Henrard and Thell. Medel. van Rijks Herb. Leid. 34: 1. 1918. Type, *Heller 7675.*

Silicles variable, but seldom over 2.5 mm. long, the apices various, but divergent; scales on fruits numerous. (Plate XVI, figs. 3, 3a.)

Mohave Desert of California north to Humboldt and Elko counties of Nevada, south into Lower California.

Representative material. CALIFORNIA: without locality, *Bigelow* (G), *Fremont* (G); Mohave River, *Palmer* in 1876 (F, MBG); Los Angeles County, Lancaster, *Elmer 3653* (C, CA, G, MBG, NY, S, US); Kern County, Kramer, *Heller 7675,* type collection *L. flavum* var. *apterum* (C, G, MBG, NY, PA, S), 2–5 miles north of Rosamund, *Abrams 11164* (F, NY, S); Barstow and vicinity, *Hitchcock 12255* (MBG, P), *Parish 9664* (C, G, MBG, S); Inyo County, Shepherd Canyon, Argus Mountains, *Coville & Funston 734,* type collection *Sprengeria minuscula* (G, NY), mouth of Black Canyon, White Mountains, *Duran 538* (CA, F, MBG, NY, P, S, US, W); Benton, Mono County, *Jones* in 1897 (NY, P). NEVADA: Las Vegas, *Goodding 2298* (C, G, MBG, NY, W); Amargosa Desert, Nye County, *Jones* in 1907 (P); Humboldt Lake, *Jones 3001* (CA, MBG, NY, P, S, US); Humboldt Valley, *Watson 126,* Type collection *Sprengeria Watsoniana* (G, NY). NEW MEXICO: near Albuquerque, *Coulter* in 1897 (G). Apparently this last collection is mislabelled or represents a chance introduction of the species. *L. flavum* has not since been reported from New Mexico.

The writer can see no good reason for recognizing the species and the variety cited in synonymy above. *Sprengeria Watsoniana* Greene differs in no significant way from typical material of *L. flavum;* leaf characters (upon which this species was founded, largely) vary greatly in this group, and in the isotype of Greene's species at the Gray Herbarium the basal leaves are divided almost to the midvein, that is, they are normal for the species.

Sprengeria minuscula Greene is apparently only an ecological variant, with small fruits such as are frequently found on plants that have grown in unusually dry soil.

Lepidium flavum var. *apterum* was founded on a collection of plants with fruits almost devoid of apical wings. With the

material at the disposal of the authors it is not surprising that Heller's collection was considered sufficiently unusual to be named. However, there seems to be little constancy in the length or divergence of the apices of the fruits in *L. flavum,* and other plants of Heller's collection have more "normal" wings. It is not unusual to find plants that exhibit great variation in the wings of the different fruits. Jones' collection of May 13, 1927, from Lone Pine, includes specimens that are not unlike those of the type of var. *apterum.*

20b. Lepidium flavum var. **felipense** var. nov.

Silicles nearly orbicular, 3–4 mm. long, 3–3.5 mm. broad, with very small winged apices, almost devoid of scales; style only 1–1.5 mm. long. (Silicula fere orbiculata, 3–4 mm. longa, 3–3.5 mm. lata, apice leviter emarginata, fere illepidata; stylo 1–1.5 mm. longo). (Plate XVI, fig. 3b.)

Type: San Felipe, California, May–Oct. 1898, *Purpus,* Pomona College Herb. no. *142;* collection also at the Rocky Mountain Herbarium, University of Wyoming.

Known only from the San Felipe region of the Coachella Valley of southern California.

Material seen. California: San Felipe, *Purpus* in 1898 (P type, W), *Brandegee* in 1895 (C); canyon west of Borrego Springs, *Jones* in 1906 (P); Iron Wood Well, Colorado Desert, *Brandegee* in 1905 (C); Cuyamaca, San Diego County, *Brandegee* in 1894 (C).

The unusual size and shape of the silicles, their lack of scales, and the short styles are the outstanding characters of this variety.

21. Lepidium fremontii Wats. Bot. King Exped. 30. pl. 4, figs. 3–4. 1871.

Suffruticose, glabrous and glaucous perennials 4–8 dm. tall, freely branched; leaves 3–10 cm. long, mostly pinnatifid into few (3–9) lobes, the lobes 1–3 mm. broad, upper leaves sometimes entire, linear, 2–3 mm. broad; inflorescence much branched, somewhat leafy; sepals 1.5–2 mm. long, glabrous; petals *ca.* 3 mm. long, white; filaments glabrous; silicles broadly ovate to obovate, 4–7 mm. long and nearly as broad, with wide winged margins, faintly nerved; styles 0.4–0.8 mm. long; cotyledons incumbent. (Plate XVII, fig. 6.)

Deserts of northwestern Arizona, extreme southwestern Utah, southern Nevada, and southern California.

Representative material. Arizona: road from Chloride to the river, Coconino County, *Eastwood 18336* (CA, US); Yucca, Mohave County, *Jones 3916* (CA, F, G, NY, P, US, WSC). Utah: St. George and vicinity, *Parry 17* (F, G, MBG, NY, P, PA). Nevada: Trinity Mountains, Pershing County, *Watson 120* (G, NY); Candelaria, *Jones 3788* (CA, G, MBG, NY, P, S, US, W); near Las Vegas, *Tidestrom 8601* (F, MBG, NY). California: near Lone

Pine, *Coville & Funston 891* (G, NY, US); Panamint Mountains, *Coville & Funston 612* (F, G, MBG, NY); Mohave River, *Palmer 17* (C, G, NY, US), *Fremont 316*, in 1844, type collection (NY); near Shaver's Well, Riverside County, *Howell 3305* (C, CA); near Cottonwood Springs, *Hitchcock 12221* (M, MBG); Lancaster, *Elmer 3632* (C, CA, G, MBG, NY, P, S, US).

Material from the region of Las Vegas, Nevada, usually has shorter styles than most of the other plants seen, but a few of the collections from the Antelope Valley and from near Bakersfield, California, consist of plants of this nature also. They are not considered of sufficient taxonomic significance to warrant their segregation.

22. Lepidium montanum Nutt.; Torr. and Gray, Fl. N. Am. 1: 116, 669. 1838.

Biennial (?) or perennial, often somewhat suffrutescent; stems 1–several, freely branched to simple, glabrous to densely pubescent; basal leaves 3–15 cm. long, parted to pinnatifid, the divisions often again lobed to pinnatifid, petiolate, stem leaves reduced, pinnatifid, lobed, or entire, short-petiolate to sessile, glabrous to slightly puberulent; sepals 1–2 mm. long, glabrous to pilose on back; petals white (pale cream?) usually nearly twice length of sepals; stamens 6 (2), filaments glabrous (pilose); silicles ovate or elliptic-ovate, 2.5–4 mm. long, 2–2.5 mm. broad, with very narrow winged margin above, slightly emarginate and with minute notch at apex, glabrous (puberulent); styles 0.3–1 mm. long; cotyledons incumbent. (Plate XVI, fig. 4, 4a–4f.)

This complex shows tremendous variation in leaf form, pubescence, habit, and in fruit size and shape; however, the fruits and flowers of the whole group of forms that have been recognized by other workers as specific entities are alike in essential features, and it seems most wise to treat the group as a single species with several fairly well marked varieties which can be separated as follows:

Key to Varieties of L. montanum

Leaves entire, or at most only crenate-dentate.
  Leaves all entire, thick, acute; stems and sepals rather densely hairy; stamens usually two . . . 22o. *L. montanum* var. *integrifolium*
  Leaves, at least the basal ones, crenate or crenate-serrate, at least at apex, stamens usually six . . . 22m. *L. montanum* var. *spathulatum*
Leaves, some of them, lobed to parted or divided.
  Stems glabrous below inflorescence.
    Cauline leaves averaging about 2 mm. broad, nearly all entire.
      Stems 4.5–10 dm. tall, practically unbranched below inflorescence . . . 22l. *L. montanum* var. *Eastwoodiae*

Stems mostly less than 4.5 dm. tall, usually branched rather profusely all the way to top . . . . 22n. *L. montanum* var. *angustifolium*

Cauline leaves averaging nearly 4 mm. broad or more; if narrower, at least some of them lobed or divided.

Cauline leaves entire, or at most deeply crenate-dentate, some of them 6–10 mm. broad . . . . 22f. *L. montanum* var. *heterophyllum*

Cauline leaves usually more deeply divided, but if not, then less than 6 mm. broad.

Plant entirely glabrous; stems slender, the cauline leaves often with variously lobed divisions . . . . 22g. *L. montanum* var. *glabrum*

Plant with some pubescence, either on basal leaves or on parts of inflorescence, or on both . . . . 22j. *L. montanum* var. *Jonesii*

Stems pubescent below inflorescence as well as above (sometimes very obscurely so).

Filaments densely bearded . . . . 22e. *L. montanum* var. *papilliferum*

Filaments glabrous, or at least not bearded.

Cauline leaves nearly all entire.

Upper cauline leaves linear to elliptic or oblanceolate, some, at least, 4 mm. broad . . . . 22l. *L. montanum* var. *Eastwoodiae*

Upper cauline leaves linear or nearly so, mostly less than 3 mm. broad . . . . 22k. *L. montanum* var. *alyssoides*

Cauline leaves, many of them, lobed, toothed, or divided.

Leaves mostly basal, cauline few, far apart, much reduced, some entire; divisions of basal leaves from ovate to obovate.

Stems practically leafless, plants usually less than 2 dm. tall; basal leaf-divisions nearly obovate . . . . 22h. *L. montanum* var. *alpinum*

Stems sparingly leafy; plants usually 2 dm. or more tall; basal leaf-divisions mostly ovate to oblong . . . . 22i. *L. montanum* var. *tenellum*

Leaves rather evenly distributed, upper more numerous than in the two preceding varieties, not greatly reduced, divisions of basal leaves narrower than ovate; stems usually quite densely (though minutely) pubescent.

Cauline leaves divided nearly as deeply as basal leaves; plants with several to many stems of equal length; low, usually not over 1.5 dm. tall . . . . 22b. *L. montanum* var. *typicum* f. *wyomingense*

Cauline leaves not divided so deeply as basal ones; plants usually with central more sturdy stem, usually over 1.5 dm. tall.

Plants quite woody at base, the stems one to several but quite sturdy; cauline leaves simple or but few-lobed; fruiting racemes usually 6 cm. long or more.

Stems glabrous or but very sparsely pubescent below inflorescence; often tortuous between nodes .... 22j. *L. montanum* var. *Jonesii*

Stems definitely pubescent from base to inflorescence, not tortuous.

Upper cauline leaves linear or nearly so, mostly less than 3 mm. broad; stems usually freely branched below ...... 22k. *L. montanum* var. *alyssoides*

Upper cauline leaves linear to elliptic or oblanceolate, some at least 4 mm. or more broad; stems 4.5–10 dm. tall, mostly simple below .... 22l. *L. montanum* var. *Eastwoodiae*

Plants not woody at base, stems usually slender; upper cauline leaves often several-lobed and nearly pinnatifid; fruiting racemes but 2–4 (5–6) cm. long.

Stems usually densely hirtellous-puberulent, although sometimes rather obscurely so, the hairs very slender and terete, 5–8 times as long as thick; plants of Nevada and western Utah mostly .... 22c. *L. montanum* var. *canescens*

Stems with pubescence of different kind than above.

Stems beset with very short, thick hairs, or appearing almost mealy or scurfy under the lens; the hairs 2–3 times as long as thick .... 22a. *L. montanum* var. *typicum*

Stems densely short puberulent-papillose, hairs not many times longer than thick; appearing somewhat glaucous or powdery; plants of northwestern Arizona .... 22d. *L. montanum* var. *canescens* f. *cinereum*

22a. Lepidium montanum var. typicum nom. nov.

L. montanum Nutt.; Torr. and Gray, Fl. N. Am. 1: 116, 669. 1838.

L. corymbosum Hook. and Arn. Bot. Beech. 323. 1840. Type, American Falls of Snake River, *Tolmie.* A specimen of the type collection has been seen. It is good representative material of this variety.

L. utaviense Regel, Acta Hort. Petrop. 1: 92. 1871. Grown from seeds collected by Roezl in Utah. From the description this segregate would seem to belong here.

L. montanum var. *stenocarpum* Thell. Monog. Lepid. 210. 1906. The type, *Palmer 279,* from Blackfoot, Idaho, is good representative material of this variety.

L. scopulorum f. *nanum* Thell. Monog. Lepid. 211. 1906. The type, *Parry 23,* from Wyoming, is not significantly different and certainly is not related to *L. scopulorum.*

L. brachybotryum Rydberg, Bull. Torr. Bot. Club 34: 427. 1907. The type, *Goodding 1075,* from Juab, Utah, can be referred here. The short styles and racemes, and rounded pods mentioned as distinctive are common to the typical variety.

L. philonitrum Nelson and Macbride, Bot. Gaz. 56: 474. 1913. Type collected at Falk's store, Canyon County, Idaho, *Macbride 32.* The authors were apparently contrasting the plant with var. *alyssoides* and var. *Jonesii,* rather than with typical *L. montanum* with which it agrees quite well.

Biennials or perennials from rather simple or branched caudex, plants usually with central main stem and several laterals of nearly same length, forming rounded plant 2–3 (1–4) dm. tall, sparsely to densely pubescent with thick papillary or clavate hairs 2–4 times as long as thick; basal leaves pinnate or pinnately divided, the divisions usually again lobed or incised, cauline leaves reduced, upper entire or lobed to parted; racemes mostly 2–4 cm. long, many-flowered; petals white; filaments glabrous; fruits ovate, 2.5–3 mm. long, glabrous.

Northwestern Colorado, southwestern Wyoming, northern Utah and southern Idaho, chiefly in valleys.

Representative material. Colorado: South Park, *Wolf & Rothrock 623* (G). Without definite locality: Snake country, *Tolmie,* probably type collection *L. corymbosum* (from American Falls, Idaho?) (G), plains of Rocky Mountains to western Washington, *Nuttall* (G, NY, PA type). Wyoming: South Pass, *Parry 23,* type collection of *L. scopulorum* f. *nanum* (G); Gros Ventes Pass, *Hayden* in 1860 (MBG). Utah: Weber Valley, Summit County, *Watson 121* (G, NY, US); 16 miles up Salina Canyon, Sevier County, *Jones 5412b* (P, US); 24 miles west of Delta, Millard County, *Maguire & Becraft 3923* (C); Juab, Juab County, *Goodding 1075,* type collection of *L. brachybotryum* and really intermediate between var. *typicum* and var. *canescens,* but closer to the former (C, F, G, MBG, NY type, P, W, US); Provo, Utah County, *Deeker 26-9* (NY); near Logan Air Port, *Muenscher & Maguire 2331* (C, MBG, P, W); near Grantsville, Tooele County, *Garrett 2868* (NY). Idaho: Soda Springs, Bannock County, *Payson & Payson 1704* (CA, G, MBG, NY, W); Blackfoot, Bingham County, *Jones* in 1909 (P), *Palmer 279,* type collection of *L. montanum* var. *stenocarpum* (C, CA, F, G, MBG, NY, W); Idaho Falls, Bonneville County, *Nelson 10044* (C, MBG, W); Falk's Store, Canyon County, *Macbride 32,* type collection of *L. philonitrum* (C, F, G, MBG, NY,

S, US, W type, WSC). NEVADA: Fish Creek, *Brandegee* in 1885 (G). Several collections, of which the following are representative, are more or less intermediate between var. *typicum* and var. *canescens*. UTAH: Morgan, Morgan County, *Jones* in 1919 (P); Sevier Bridge, Millard County, *Jones 1896* (F, NY, P). NEVADA: Wells, *Jones* in 1901 (P). *Tidestrom 1209* (US), west of Ephraim, Wasatch Mountains, San Pete County, Utah, is very unusual in that the cauline leaves are almost entire, as in var. *alpinum*, yet it has the pubescence of var. *typicum*. A collection from South Park, Colorado, *Porter 473* (MBG), is intermediate in character between this variety and var. *alyssoides*, being like the latter in general habit, but with the pubescence of var. *typicum*.

22b. LEPIDIUM MONTANUM var. TYPICUM f. **wyomingense** f. nov. Much like the typical variety, but the stems several, about equal, seldom over 1.5 dm. tall, plants biennial or perennial; basal leaves pinnately divided, the divisions lobed or parted, cauline leaves somewhat reduced, scarcely any entire, often divided and with the divisions lobed; sepals slightly pilose usually; petals usually pale lemon. (Similissimum *L. montano* var. *typico*, sed caules complures, aequales; 0.5–1.5 dm. alta; petala fere lutea?) (Plate XVI, fig. 4c.)

Type: Laramie, Albany County, Wyoming, June 16, 1896. *Nelson 1947* (W type, G, MBG, NY).

Southern Wyoming, and adjacent Colorado and Utah in the high plains region.

Representative material. COLORADO: Pitkin, Gunnison County, *Underwood & Selby 409* (NY). UTAH: Willow Spring Pass, *Jones* in 1891 (P). WYOMING: Fish Hatchery, *Buffum 93* (W); Cottonwood Canyon, Laramie, *Nelson 1569* (G, W); Laramie, *Nelson 1947* (G, MBG, NY, W), *Nelson 221* (NY), *Macbride 2381* (MBG); Bitter Creek, *Nelson 3106* (P, W); Sand Creek, Albany County, *Nelson 7035* (G, I, MBG, NY, P, W); Red Buttes, *Nelson* in 1903 (W); Laramie Plains, *Osterhout* in 1897 (F, P); Near Rock Springs, Sweetwater County, *Payson & Payson 4306* (W); Henry's Fork, Uintah Mountains, *Goodding 1190* (G, MBG, P, W) intermediate between this and var. *alpinum*; near Flackert's Ranch, *Merrill & Wilcox 728* (G, NY, W) of same nature as *Goodding 1190*.

22c. LEPIDIUM MONTANUM var. **canescens** (Thell.) comb. nov. *L. scopulorum* f. *canescens* Thell. Monog. Lepid. 211. 1906. The type, *Baker 1190*, from Eagle Valley, Nevada, is certainly not the same as *L. scopulorum* Jones which is herein treated as a variety of *L. montanum*.

L. albiflorum Nelson and Kennedy, Muhlenbergia 3: 138. 1908. The type, *Brown 66*, from Spanish Spring's Valley, Washoe County, has not been seen. However, the description can leave little doubt as to the nature of the plant and this is the only form of such nature occurring in that portion of Nevada.

Usually biennial, possibly perennial, sometimes blooming the first year, about 3 dm. tall, round-topped, whole plant except flowers and fruits sparsely to densely villose and almost canescent, the hairs slender; basal leaves pinnately divided, the divisions entire and about 1 (1.5) mm. broad, hirsute; cauline leaves

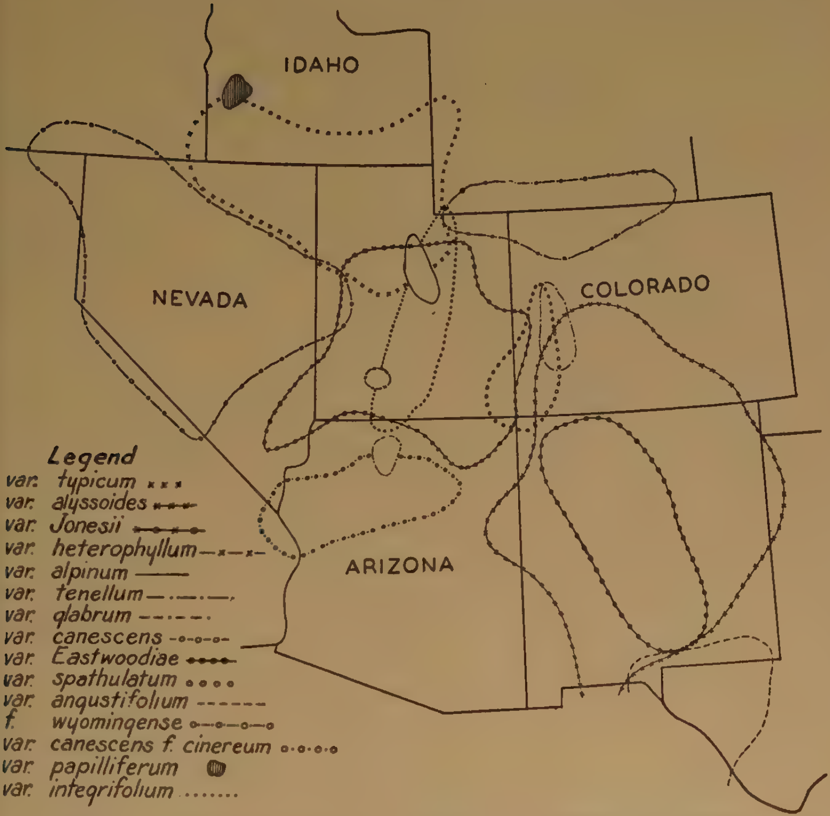

Fig. 1. Distribution map of varieties of *Lepidium montanum.*

reduced, rather few (4–7), some entire, but some, at least, lobed and parted or divided, the divisions about 1 mm. broad; racemes short and many-flowered, mostly 2–4 cm. long; calyx conspicuously pilose; filaments glabrous, fruits ovate, *ca.* 2.5 mm. long, glabrous. (Plate XVI, fig. 4e.)

Central and northern Nevada and adjacent Utah, California, and Oregon, usually on sagebrush flats. Characterized chiefly by the pubescence and low habit.

Representative material. UTAH: Emmington, *Jones* in 1880 (P); Old Dugway, Tooele County, *Jones* in 1891 (P); Wendover, Tooele County, *Van Dyke* in 1930 (CA). NEVADA: Pah Ute Mountains, *Watson 123* (G); near Wendover, Elko County, *Eastwood & Howell 356* (CA), *Jones 25313* (MBG, P); Battle Mountains, Elko County, *Kennedy 3077* (S); between Imlay and Battle Mountains, *Eastwood & Howell 160* (CA, M); Reno, Washoe County, *Jones* in 1897 (P), Steamboat Creek, *Stretch 111* (NY); Carson City, Ormsby County, *Jones* in 1897 (P), *Anderson 142, 230* (G, US); Eagle Valley, *Baker 1190*, type collection (G, MBG, NY, P, US), *Baker 1264* (P), Empire City, *Jones 3003* (CA, MBG, NY, P, US).

The following collections are much less pubescent than the material cited above and perhaps are worth nomenclatural status. However, although some of the plants are practically glabrous, the few hairs that are present are of the type found in this variety. In general habit also the plants resemble var. *canescens*. OREGON: near McDermitt, *Cusick 2023* (C, F, G, MBG, W, WSC); Narrows, Harney County, *Peck 5259* (F, G); Denio, Harney County, *Train 38* (US), *Griffiths & Morris 400* (US). CALIFORNIA: north of Gazelle, Siskiyou County, *Heller* in 1925 (S); Grenada Station, Siskiyou County, *Heller 8068* (F, G, MBG, NY, PA, S); three miles south of Grenada, Siskiyou County, *Wheeler 3639* (M, LW); near Yreka, Siskiyou County, *Green 844* (G, MBG); between Gazelle and Grenada, Siskiyou County, *Heller 14610* (MBG, NY, S, US); Pitt River south of Alturas, Modoc County, *Austin 336* (C); Alturas, Modoc County, *Howell 12182* (CA); Black Lake, Mono County, *Duran 3347* (C, CA, F, MBG, S, US, W, WSC).

22d. LEPIDIUM MONTANUM var. CANESCENS f. **cinereum** f. nov. Stems, leaves, and sometimes fruits densely cinereous papillose-puberulent and pulverulent, the hairs about twice as long as thick; sepals pilose on back; filaments (and usually fruits) glabrous; fruits 3–3.5 mm. long. (Caulis foliaque valde cinereo-puberulenta et pulverulenta; sepala glabra; filamenta glabra; silicula 3–3.5 mm. longa.)

Type: collected on sagebrush flat, Seligman, Arizona, Aug. 14, 1935, *Hitchcock 2866*, University of Montana (Herb. No. 23,674).

Northwestern Arizona at elevation of 1000–2100 meters; occasional in adjacent California.

Representative material. ARIZONA: 18 miles below Black Falls, Little Colorado, *Ward* in 1901 (US), hairs several times as long as thick; Pinedale, Navajo County, *Hough 106* (US), near Leupp, *Peebles 9580* (US); 50 miles south of Lee's Ferry, Coconino County, *Jones* in 1890 (P), between Williams and Grand Canyon, *Degener 4842* and *4530* (NY), Seligman, *Eastwood 5929* (CA), *Hitchcock 2866* (M), west of Cameron, *Hanson 101* (W); Hackberry, Mohave County, *Jones* in 1903 (P); road to Peach Springs from Kingman, *Eastwood 18670* (CA, US); 20 miles west of Ashfork, *Hitchcock 2864* (M); 20 miles east of Ashfork, *Hitchcock 2865* (M). CALIFORNIA: Barnwell, New York Mountains, San Bernardino County, *Ferris & Bacigalupi 8106* (C, P, S), *Munz 13708* (M, P); Fourth of July Canyon, New York Mountains, *Jaeger* in 1932 (CI, P).

This form is about the same as var. *canescens* except that the hairs are more like papillae and much shorter. One collection, *Eastwood 18670*, has densely pubescent fruits, the only specimen of *L. montanum* seen by the writer with such fruits.

22e. LEPIDIUM MONTANUM var. PAPILLIFERUM Henderson, Bull. Torr. Bot. Club 27: 342. 1900.

L. papilliferum (Henderson) Nelson and Macbride, Bot. Gaz. 56: 474. 1913. The authors cite their number *1068* as the type, although it is identical with *Henderson 4121*, the type of *L. montanum* var. *papilliferum*.

Entire plant densely papillose-puberulent, the hairs appearing somewhat flattened; sepals pilose on back; petals white and

very conspicuous; filaments bearded with same type of pubescence as on stem. Otherwise as in var. *typicum.*

Idaho; the only collections seen are from Canyon County, and from near Boise.

Material seen. IDAHO: near Nampa, Canyon County, *Henderson 4121,* type collection (G, S, US, WSC), *Mulford* in 1892 (G, MBG, NY), *Nelson & Macbride 1068* (W); New Plymouth, Canyon County, *Macbride 91* (C, F, G, MBG, NY, S, US, W, WSC); Emmet, Canyon County, *Macbride 880* (C, F, G, MBG, NY, P, S, US, W, WSC); Boise, *Jones* in 1917 (P), *Gageby* in 1916 (W).

22f. LEPIDIUM MONTANUM var. **heterophyllum** (Wats.) comb. nov.

L. integrifolium var. *heterophyllum* Wats. Am. Nat. 9: 268. 1875.

L. scopulorum Jones, Proc. Calif. Acad. ser. 2, 5: 625. 1895, in part. A name proposed for Watson's entity when Dr. B. L. Robinson pointed out that *L. heterophyllum* was preoccupied as a specific name. Jones interpreted this group by what he supposed were the same plants from the Wahsatch Mountains (whence came *Watson 122*), but which are in reality different, belonging to var. *alpinum.*

Whole plant glabrous, or with very few hairs chiefly on basal leaves; stems few from rather heavy root-crown, rather sturdy, 2–3 dm. tall; leaves glabrous or with very few hairs, basal deeply serrate to incised and lobed, mostly over 1 cm. broad, cauline somewhat reduced and more frequently entire, 6–10 mm. broad.

Known only from the type locality, near Cedar City, Utah, but apparently from higher elevations than var. *integrifolium* and not from saline soil.

Material seen. UTAH: without definite locality, *Parry 14* (US); near Cedar City, Iron County, *Parry 16* (F, G type, MBG, PA), *Jones 5204t* (P), *Cottam, Stanton & Harrison 3968* (P).

The peculiar leaves and glabrosity of this plant are the chief characters of significance. It is closest to var. *glabrum* from Grand Canyon, but the leaves and branches are very different. The plants are taller and different in aspect from either var. *alpinum* or var. *tenellum,* the other somewhat similar groups.

22g. LEPIDIUM MONTANUM var. **glabrum** var. nov.

Entire plant glabrous, suffrutescent; stems diffusely branched, as much as 6–7 dm. tall, ending in exceedingly slender branchlets; whole plant quite leafy, the basal leaves as much as 4 cm. broad, from deeply lobed to divided, the divisions sometimes cleft to parted; lower cauline leaves not greatly reduced; racemes few-flowered, leafy, on very slender branchlets; silicles ovate-rotund, but little over 2 mm. long on material seen.

(Planta glabra 4–7 dm. alta; caulibus ramosissimis, ramis gracilibus; folia glabra, basilaria ad 4 mm. lata; racemis paucifructiferis, gracilissimis; silicula ovato-rotundata, ca. 2.5 mm. longa).

Type: Hermit Trail, Grand Canyon, Arizona, June 18, 1916, *Eastwood 5826* (CA). Known only from the Grand Canyon and the San Francisco Mountains.

Material seen. Arizona: Grand Canyon, Yavapai County, *Wooton* in 1892 (US); Trail from Grand View, Grand Canyon, *Eastwood 3596* (CA); north rim Grand Canyon, *Eastwood & Howell 975* (CA); Hermit Trail, Grand Canyon, *Eastwood 5826* (CA type, G); rim of Grand Canyon, *Hitchcock* in 1915 (US); Grand Canyon along river, *Toumey 54* (S); San Francisco Mountains, *Toumey 55* (US).

The glabrosity of this plant, the unusual leaf form, the capillary branches, and the small, nearly round fruits are outstanding.

22h. Lepidium montanum var. alpinum Wats. Bot. King Exp. 29. 1871.

L. scopulorum Jones, Proc. Calif. Acad. ser. 2, 5: 625. 1895, in large part, according to Jones' notations on herbarium material.

L. heterophyllum Jones, Zoë 3: 284. 1893, proposed as a name for *L. montanum* var. *alpinum* Wats., later changed to *L. scopulorum*.

Plants somewhat spreading at base, usually about 1.5 (2.5) dm. tall, the stems slender, rather numerous, sparsely puberulent, leaves mostly basal, parted or more frequently divided, the divisions variously lobed or entire, ovate to obovate, cauline leaves few, usually but 2–3 per stem, much reduced; racemes very short, 2–3 cm. long, flowers closely crowded, the pedicels ascending, but occasionally sigmoid; sepals and filaments glabrous; silicles about 3 mm. long or less, glabrous. (Plate XVI, fig. 4f.)

Known only from the cliffs and ledges of the Wahsatch and Oquirrh Mountains of Utah.

Material seen. Utah: Wahsatch Mountains, *Watson 122* (G type, NY, US); Little Cottonwood Canyon, Wahsatch Mountains, *Jones* in 1907 (C, CA, MBG, NY, P, S); Lake Blanche, Wahsatch Mountains, *Clemens* in 1911 (CA, NY, P, W), *Treakle 320* (P), *Jones* in 1895 (MBG, P, S); Alta, Wahsatch Mountains, Salt Lake County, *Jones 1270* (F, NY, P, S); gorge near Alta, *Leonard 212* (NY); Oquirrh Mountains, *Jones* in 1893 (NY); without definite locality, *Ward 209* (PA).

The variety is striking because of the nearly leafless, sparsely pubescent stems, and large divisions of the basal leaves; the habitat and habit are also unusual.

22i. Lepidium montanum var. tenellum (Williams) comb. nov.

L. tenellum Williams, Bull. Torr. Bot. Club 61: 259. 1934. *Payson 1033,* from Gunnison, Colorado, type.

Plants more or less suffrutescent and somewhat decumbent at base, sparingly puberulent to practically glabrate; leaves mostly basal, parted or divided, the divisions entire or sometimes lobed, cauline leaves mostly 3–5, very much reduced, the upper entire; sepals slightly pilose on back usually; styles about 0.5 mm. long; fruits about 3 mm. long, glabrous.

From the canyons of west central Colorado.

Material seen. COLORADO: rock crevices near railroad, Black Canyon of Gunnison, Gunnison County, *Payson 1033* (W type); Cimarron, Montrose County, *Jones* in 1890 (P), *Jones* in 1925 (P); Glenwood Springs, Garfield County, *Osterhout 2579* (NY), *Diehl* in 1899 (P), *Payson 1193* (MBG, W); Glenwood, *Eastwood 7202* (CA); Meeker, Rio Blanco County, *Robbins 7139* (W); without definite locality, *Meredith* in 1895 (PA).

In all material seen the stems tend to be decumbent, although the type is more slender than most of the material referred here. This variety is very similar to var. *alpinum,* but the plants are somewhat taller and the stems are more leafy. There is the possibility, of course, that it is only a minor variation of Watson's variety.

22j. LEPIDIUM MONTANUM var. Jonesii (Rydberg) comb. nov.

L. Jonesii Rydberg, Bull. Torr. Bot. Club 29: 233. 1902.

L. alyssoides var. *Jonesii* (Rydberg) Thell. Monog. Lepid. 208. 1906.

L. montanum var. *alyssoides* Jones, Zoë 4: 266. 1893, in large part, particularly plants of Utah.

L. tortum Williams, Bull. Torr. Bot. Club 61: 260. 1934. The type, *Goodding 2281,* from Las Vegas, Nevada, has some pubescence on the stem, otherwise it is not unusual.

L. Crandallii Rydberg, Bull. Torr. Bot. Club 34: 427. 1907. The type, collected at Palisades, Colorado, *Crandall 131,* is more or less intermediate between var. *Jonesii* and var. *alyssoides,* but is representative of the intergrades where the two varieties overlap in range.

L. alyssoides var. *stenocarpum* Thell. Monog. Lepid. 208. 1906. The type, *Baker 12,* Montrose, Colorado, is really intermediate between var. *Jonesii* and var. *alyssoides.* The same can be said for this synonym as for *L. Crandallii.*

Plants suffrutescent, 1.5–3.5 dm. tall, with one or more stems, branched from base to top, often quite crooked or tortuous, usually glabrous below inflorescence, sometimes puberulent; basal leaves divided, the divisions dissected or parted, cauline leaves numerous, the lower mostly with 2–5 deep lobes, the upper simple or less deeply lobed, usually with few hairs; fruiting racemes 3–7 cm. long; sepals glabrous to slightly pilose on

back; filaments glabrous; fruits glabrous, 2.5–4 mm. long. (Plate XVI, figs. 4, 4a, 4b.)

Southern and central Utah and adjacent Colorado, Arizona, and Nevada, chiefly at medium altitudes.

Representative material. COLORADO: Palisades, Mesa County, *Crandall 10* (G); Grand Junction, *Jones* in 1895 (MBG, P), *Macbride & Payson 698* (W); Montrose, *Payson 653* (G, W). UTAH: San Juan River, near Bluffs, *Rydberg & Garrett 9972* (NY); vicinity of Moab, *Harrison 5965* (MBG), *Rydberg & Garrett 8426* (NY); west of Vernal, Uintah County, *Williams 612* (CA, MBG, NY, W); Green River, *Jones* in 1895 (CA, MBG, NY, PA); near Emery, *Jones 5445a* (C, MBG, NY, P, US); Cainville, Wayne County, *Jones 5696b* (NY, P, US); Kaibab, *Cottam 4327* (P); near St. George, *Parry 18* in 1874 (F, G, MBG, NY), *Jones 1636* (CA, F, G, NY type, P, PA, S, US, W, WSC). ARIZONA: Segi Canyon, Navajo Indian Reservation, *Clute 89* (W); 5 miles northeast of Holbrook, *Ward* in 1901 (US) approaching f. *cinereum;* Mokiah Pass, *Palmer 39* (MBG, NY). NEVADA: Horse Spring, Clark County, *Jones 5066* (MBG, NY, P, S); Las Vegas, *Goodding 2281,* type collection of *L. tortum* (C, G, MBG, NY, W type).

The following collections are more or less intermediate between var. *Jonesii* and var. *alyssoides,* and were made where the ranges of the two varieties overlap. COLORADO: near Delta, Delta County, *Osterhout* in 1926 (P); Grand Junction, *Eastwood 5200* (CA); Palisades, *Crandall 131* (NY, W); Montrose, *Baker 12,* type collection of *L. alyssoides* var. *stenocarpum* (C, G, MBG, NY, P, US, W). Gallup-Shiprock road, New Mexico, *Nelson 10377* (C, M, MBG, NY, W). Jones' collection of 1895 from Grand Junction, Mesa County, Colorado, is more or less intermediate between the varieties *Jonesii* and *alpinum.*

This variety differs from var. *Eastwoodiae* in its lower form and by having a more branched habit, divided leaves, and tortuous branches. It is something like var. *typicum* and var. *canescens* in leaf form, but is much more woody and less pubescent.

22k. LEPIDIUM MONTANUM var. ALYSSOIDES (Gray) Jones, Zoë 4: 266. 1893, in large part.

L. alyssoides Gray, Pl. Fendl. (Mem. Am. Acad. Nat. Sci. 4: 10. 1849) 10. 1849.

L. alyssoides var. *minus* and var. *polycarpum* Thell. Monog. Lepid. 208. 1906. The type collections, by *Porter* in 1872, at South Park, Colorado, and by *Engelmann* in 1874, near Canyon City, Colorado, are unusual plants, but both are pubescent and are not deemed of sufficient difference to merit recognition. The variety *polycarpum* is especially interesting because of the crowded condition of the racemes. If it is not a chance variation as is suspected, it would seem to be worth some recognition.

Plants suffrutescent with one or more freely branched stems 2.5–5 dm. tall, puberulent; basal leaves nearly bipinnatifid, lower cauline leaves sometimes lobed to parted, but mostly entire, upper ones always entire, averaging 2–3 mm. broad and 2–4 cm. long; calyx glabrous or slightly pilose; filaments and fruits glabrous.

Southern Colorado, New Mexico, and adjacent Texas, at lower altitudes, but intergrading with var. *angustifolium* in the south.

Representative material. TEXAS: Rainwater Creek, *Wright 1324* (G, MBG, PA, US). NEW MEXICO: without locality, *Wright 1325* (C, G, PA, US); Copper Mines, Grant County, *Thurber 1113* (G, NY); Gray, Lincoln County, *Skehan 48* (C, F, G, MBG, NY, P, US, W); Roswell, *Earle & Earle 254* (MBG, NY, P, US); south of Atarque de Garcia, Valencia County, *Wooton* in 1906 (NY); between San Miguel and Vegas, *Fendler 46* (C, G type, MBG); Tres Piedras, Taos County, *Earle 55* (MBG, NY). ARIZONA: Holbrook, *Zuck* in 1896 (MBG, NY, US). COLORADO: near Bent's Fort, *Fremont 480* (G, MBG, NY); Pueblo, *Greene* in 1873 (F, G, NY); east of Florence, *Clokey 4141* (CA, F, MBG, P, PA, S, US, W); Arkansas Valley, Fremont County, *Jones* in 1878 (P), near Canyon City, *Jones 766* (P) and *Engelmann* in 1874 (MBG), the last two numbers cited by Thellung under var. *polycarpum;* South Park, *Porter* in 1872 (G), type collection of var. *minus* Thell.; Poncho Pass, Chaffee County, *Bethel, Willey & Clokey 4133* (CA, F, M, MBG, NY, P, PA, S, W, US); Paradox, *Payson 2324* (CA, G, MBG, NY, W); Grand Junction, *Eastwood 5162,* approaching var. *alpinum* (CA, S). UTAH: Glenwood, *Ward 160* (MBG) between var. *alyssoides* and var. *Jonesii* as is the collection from Sevier Valley near Richfield, *Ward 253* (F, G, MBG).

The following collections from Texas are representative of the intergrades between var. *angustifolium* and var. *alyssoides*: Canyon City, *Palmer 12527* (C, MBG, W), *Reverchon 3713* (MBG, NY); Pecos, *Palmer 34020* (MBG, NY, PA); Barstow, *Tracy & Earle 24a* (C, F, G, MBG, NY, US); El Paso, *Jones 4199* (CA, F, G, NY, P, PA, S, WSC); Huecho Mountains, east of El Paso, *Hitchcock 2869* (M).

22l. LEPIDIUM MONTANUM var. **Eastwoodiae** (Wooton) comb. nov.

L. Eastwoodiae Wooton, Bull. Torr. Bot. Club 25: 258. 1898. *Wooton 673,* collected in the White Mountains, Lincoln County, New Mexico, is the type.

Plants suffrutescent, with one or more stems 4.5–10 (3) dm. tall, the stems unbranched or nearly so below the inflorescence, puberulent to glabrous, basal leaves parted to divided, the divisions usually toothed or lobed, cauline leaves, at least the lower sometimes parted or divided, the upper usually entire, narrowly lanceolate to oblanceolate, some at least, over 4 (4–7) mm. broad; sepals, filaments, and fruits glabrous.

Mountain ranges of central New Mexico.

Representative material. NEW MEXICO: Organ Mountains, Modoc Mine, *Standley* in 1906 (MBG); Organ Mountains, *Wooton* in 1902 (P, W), *Vasey 93* (G), Van Pattens, *Wooton* in 1899 (G, NY, US), Dripping Springs, *Munz 13265* (P); White Mountains, Lincoln County, *Wooton 673* (MBG, NY, US type); Mancos River, San Juan County, *Hutchinson 3830* (E); north of Magdalena, Socorro County, *Eggleston 16196* (US); near Albuquerque, Bernalillo County, *Palmer 31158* (MBG); Jemez Valley, Jemez Mountains, *Nelson & Nelson 236* (C, W); Sandia Mountains, *Ellis 72* (MBG, NY, US).

These plants are maintained as a variety with some doubt. Because of their greater height, wider leaves and unbranched stems they can usually be distinguished from var. *alyssoides*. The variety *Eastwoodiae* appears to intergrade with both var. *Jonesii* and var. *spathulatum* in its northern limits. Typical of intergrades with the last variety are the following: UTAH: Hammond Canyon, Elk Mountains, *Rydberg & Garrett 9574* (NY); near Bluffs, *Rydberg & Garrett 9971* (NY, W); near Wilson Mesa, Grand County, *Rydberg & Garrett 8391* (G, NY). COLORADO: Weber Canyon, *Eastwood* in 1892

(C, MBG); Rio Mancos, Montezuma County, *Brandegee 1227* (C); Naturita, *Payson 589* (F, G, MBG, S, W).

22m. Lepidium montanum var. **spathulatum** (Robinson) comb. nov.

L. scopulorum var. *spathulatum* Robinson, Gray Syn. Fl. N. Am. 1[1]: 125. 1895.

L. spathulatum Vasey, ex Robinson, Gray Syn. Fl. N. Am. 1[1]: 125. 1895, as synonym. Not *L. spathulatum* Philippi.

Thelypodium crenatum Greene, Pittonia 4: 20. 1899.

L. crenatum (Greene) Rydberg, Bull. Torr. Bot. Club 33: 141. 1906. Based on *Baker, Earle & Tracy 394,* which as Rydberg showed, is really a *Lepidium,* and is the same in all respects as Robinson's plant.

L. Vaseyana Thell. Monog. Lepid. 211. 1906, a name proposed for the group as a *species,* since *L. spathulatum* was preoccupied.

Erect plants; stems 3.5–6 dm. tall, glabrous below, puberulent above, basal leaves from serrate-crenate to merely three-notched at apex, from ovate-lanceolate to obovate, 10–20 mm. broad, the blades as much as 7–8 cm. long, narrowed to petioles nearly or quite as long, stem leaves simple or more rarely crenate at apex, reduced, yet usually 5–15 mm. broad, practically sessile, glabrous or glabrate; inflorescence rather dense and rounded, with clusters of racemes at ends of branches; sepals glabrous or sparsely short pilose; stamens 6; silicles about 3 mm. long.

Southwestern Colorado and adjacent Utah.

Representative material. Utah: head of Bear River, (possibly Colorado?) *Vasey 32* (US); Moab, *Rydberg & Garrett 8471* (NY, W); La Sal Mountains, *Rydberg & Garrett 8561* (NY, W). Colorado: west of Grand River, Rocky Mountains, *Vasey 51* (G type, MBG, US); Mesa Verde National Park, *Nelson & Nelson 304* (C, W), *Bader 290* (W), *Bethel* in 1921 (W), *Haas 29* (W); near Mancos, *Baker, Earle & Tracy 394,* type collection *L. crenatum* (C, F, G, MBG, US, W), *Munz 13044* (M, P), *Piper 3938* (W); Montrose, *Payson 936* (G, W); Paradox, *Walker 337* (G, S, US, W); Paonia, Delta County, *Eggleston 14593* (US), *Osterhout 4511* (NY); between Meeker and Craig, *Osterhout 2616* (NY, P, W). Doubtfully included here is a collection from Moab, Utah, *Jones* in 1891 (P, S), which is more or less intermediate between var. *spathulatum* and var. *Jonesii.*

This variety is characterized by the size of the plant, by the clusters of racemes at the branch ends, and by the serrate-crenate leaves. It probably is more closely related to var. *Eastwoodiae* or to var. *integrifolium* than to either var. *typicum* or var. *Jonesii.*

22n. Lepidium montanum var. **angustifolium** var. nov.

Plants erect, suffrutescent, with main stem and numerous lateral branches, glabrous below inflorescence, 3–7 dm. tall; basal leaves pinnately parted or divided, sometimes slightly

pubescent, cauline leaves very numerous, linear, mostly 1.5–2 mm. (1–3.5) broad, and 4–5 (3–6) cm. long, nearly all entire, occasionally a few incised; racemes long, many-flowered, pubescent on rachis and pedicels; sepals glabrate or slightly pilose; filaments glabrous; fruits averaging about 3 mm. long, glabrous. (Planta erecta, sub racemis glabra, 3–7 dm. alta, foliis basilariis partitis vel divisis, caulinis linearibus, 1.5–2 (1–3.5) mm. latis, 4–5 (3–6) cm. longis, plerisque integerrimis.)

Extreme southwestern Texas and adjacent New Mexico.

Type: Fabens, Texas, April 10, 1930, *M. E. Jones 25835*, Pomona College Herb. no. 178824. Collection also at California Academy of Sciences and Missouri Botanical Garden.

Representative material. TEXAS: Garvin, Wise County, *Palmer 30493* (MBG); 70 miles below El Paso, *Wright 17* (C, G, MBG, NY); 2 miles north of Pecos, *Hitchcock 2867* (M); 40 miles east of Pecos, *Hitchcock 2868* (M); Van Horn, *Jones 28110* (MBG, P); El Paso, *Palmer 31108* (MBG, PA); Canutillo, July 1, 1911, *Bronson* (CA, F); between Fabens and Yoleta, *Ferris & Duncan 2360* (CA, MBG, S); Fabens, *Jones 25835* (CA, MBG, P); Amarillo, *Reverchon* in 1902, possibly wrong locality? (MBG). NEW MEXICO: Carlsbad Caverns, *Nelson 11364* (M, W).

22o. LEPIDIUM MONTANUM var. **integrifolium** (Nutt.) comb. nov.

L. integrifolium Nutt.; Torr. and Gray, Fl. N. Am. 1: 116. 1838.

L. zionis Nelson, Bot. Gaz. 42: 50. 1906. Type, *Jones 5411*, typical in all respects.

L. utahense Jones, Bull. Torr. Bot. Club 8: 70. 1881, Zoë 4: 266. 1893. *Jones 1821*, the type, is the same as Nuttall's plant, the nature of which was unknown to Jones.

Stems somewhat decumbent, from a thick caudex, rather densely puberulent; leaves entire, thick and fleshy, elliptic to elliptic-obovate, 4–15 mm. broad, the basal with petioles as long as blade, sparingly puberulent to glabrate; sepals somewhat pilose on back; stamens 6 (2); silicles nearly 4 mm. long. (Plate XVI, fig. 4d.)

South central Utah from Sevier County northward to the Bear River, at medium altitudes, in saline soil only. Possibly in Arizona?

Material seen. Without definite locality: *Palmer 37* in 1877 (MBG, NY, US); Rocky Mountains, "plains toward the Columbia," *Nuttall* (G type, NY, PA); Bear River, *Vasey* in 1868 (US). UTAH: Carter, Uintah County, *Jones* in 1896 (P); Vermilion, *Jones* in 1894 (P), *Jones 5631a* (MBG, NY, P); Richfield, *Ward* in 1875 (G), *Jones 5411*, type collection of *L. zionis* (C, MBG, NY, P, US, W type); Glenwood, Sevier County, *Ward 217* (G, MBG, S, PA, US); Milford, Beaver County, *Jones 1821*, type collection of *L. utahense* (F, G, MBG, NY, P type). ARIZONA (?): Ft. Verde, *Mearns 309* (NY). WYOMING: Fossil Station, *Letterman 120* (G, US).

The variety *integrifolium* is outstanding because of the large fruits (although no larger than occasionally found in plants of

var. *Jonesii*), and because of the thick, fleshy, entire leaves. It is surely one of the best marked varieties in the species, but since the flower and fruit characters are the same as those of other forms of *L. montanum,* and since there is intergradation with var. *spathulatum,* it does not seem best to maintain the group as a distinct species.

23. Lepidium nanum Wats. Bot. King Rep. 30. pl. 4, figs. 5, 7. 1871.

Caespitose, matted perennials, 3–6 cm. tall; leaves densely crowded, obovate, 2–5 mm. long, 3-lobed at apex, with winged petioles, conspicuously ciliate and somewhat pubescent; inflorescence of 2–5 flowers, the axis concealed by leaves, fruiting pedicels 2–5 mm. long; sepals *ca.* 1 mm. long, minutely pubescent on back; petals pale cream or white (?), about twice length of sepals; stamens 6, filaments glabrous; silicles glabrous, ovate-elliptic, *ca.* 3.5 mm. long, 2 mm. broad, barely notched at apex; styles *ca.* 0.5 mm. long, cotyledons incumbent ("accumbent" according to Watson's description). (Plate XVI, fig. 7.)

Known only from extreme northeastern Nevada; apparently growing on dry gravelly knolls.

Material seen. Nevada: locality somewhat uncertain, Nobe Valley, *Engelmann* in 1859 (MBG); Holmes Creek Valley, Sept. 1868, *Watson 127* (G type, NY, US); Spencemont (should be Sprucemont, Elko County?), *Jones* in 1905 (MBG, NY, P); Elko County, near Halleck Station, *Wheeler* in 1871 (G), Cobre, May 22, 1906, *Jones* (NY, S), June 16, 1906, *Jones* (P), June 26, 1907, *Jones* (P).

The habit of these plants is entirely different from that of all other North American species. It is more suggestive of *Draba* than of *Lepidium.*

24. Lepidium Jaredii Brandegee, Zoë 4: 398. 1894.

Annual, 1–6 dm. tall, simple to diffusely branched, from nearly glabrous below to fairly villose-canescent; leaves lanceolate, 3–10 cm. long, 0.5–1 cm. broad, mostly entire, some with few teeth; racemes 5–20 cm. long, loosely flowered; pedicels terete, *ca.* 1 cm. long, spreading to sigmoid; sepals yellow, oblong-spatulate, pilose on back, *ca.* 2.5 mm. long; petals *ca.* 3 mm. long, sulfur-yellow; stamens 6; silicles ovate, 3–4 mm. long and as broad near base; styles 0.5–1 mm. long. (Plate XVI, fig. 5.)

Known only from collections from northeastern San Luis Obispo County and south central Fresno County (but range probably continuous through Kings County), California.

Material seen. California: San Luis Obispo County, Estrella, *Jared* (S), hills above the Carrizo Plains, May, 1893, *Jared,* type collection (CA), 16 miles south of Soda Lake, Carrizo Plain, *Ferris 9122* (S), 18 miles south of Soda Lake, *Keck & Clausen 3157* (CI, C, M, S), east side of Soda Lake, *Keck & Clausen 3138* (CI, M, S); 20 miles northeast of Corcoran, Fresno County,

Winblod in 1935 (CA). With the exception of the two collections by Jared, all material seen was collected in 1935, the collectors all reporting this relative of the *L. montanum* group to be fairly plentiful in the limited area where it occurs.

25. LEPIDIUM THURBERI Wooton, Bull. Torr. Bot. Club 25: 259. 1898.

L. alyssoides Gray, as treated by Robinson, Syn. Fl. N. Am. 1^1: 125. 1895, in part.

L. montanum Nutt. as treated by Thell. Monog. Lepid. 208. 1906, in part.

Rank growing annuals 1–6 dm. tall, stems freely branched, the plant more or less rounded, canescent-hirsute to papillose and villose-pilose, the longer hairs usually flattened, the shorter often clavate or papilliferous; basal leaves 3–6 cm. long, petiolate, pinnatifid, with 3–8 pairs of segments, these usually lobed to parted, the ultimate divisions linear to obovate, apiculate, cauline leaves somewhat reduced, pinnatifid or the upper sometimes entire; racemes many-flowered; sepals 1–1.5 mm. long, glabrous to pilose; petals white, 2–3 mm. long; stamens 6, filaments glabrous; silicles glabrous, ovate to nearly orbicular, 2–3 mm. long, 2–2.5 mm. broad, narrowly wing-margined near apex, with very shallow notch; style 0.3–0.5 mm. long; cotyledons incumbent. (Plate XVII, fig. 4.)

Extreme southwestern New Mexico; Cochise, Santa Cruz, Pima, and Yavapai counties, Arizona; south into Mexico, and possibly in California.

Representative material. NEW MEXICO: Lava, Socorro County, *Wooton 672*, type collection (MBG, NY, US); "Sonora or New Mexico," *Thurber 323* (G, NY); Valley of Coppermine Creek, Grant County, *Wright 854* (G, MBG, NY); Mangas Spring, *Metcalfe 117* (C, CA, G, MBG, NY, P, S); Florida Mountains, Luna County, *Mulford 1048* (MBG, NY); Lordsburg, Hidalgo County, *Jones 25840* (MBG, P). ARIZONA: Douglas, *Goodman & Hitchcock 1228* (CA, F, MBG, NY, S); Cochise, *Jones 28111* (CA, MBG, P); Miller Canyon, Huachuca Mountains, *Jones 24839* (CA, G, MBG, NY, P); Tucson and vicinity, *Thornber 372* (C, MBG, NY, P, S); Prescott and vicinity, *Eastwood 8845* (CA), *Wolf 2380* (CA, G, S), *Rusby 518* (F, M, MBG, NY). CALIFORNIA: Barstow Hills, Mohave Desert, *Spencer 50* (PA); Marsh Hot Springs, near Santa Rosa, Sonoma County, *Holman* in 1884 (US). It is strongly suspected that the Holman collection, and possibly the Spencer collection as well, were erroneously reported from California; at least it appears that if *L. Thurberi* occurs in that state at all, it will be found on the Mohave Desert, but certainly not within hundreds of miles of Sonoma County.

There are two minor variations apparent in the species as it occurs in Arizona. Plants from near Tucson have the upper leaves entire or practically so, and plants from Yavapai County lack the papillose or clavate hairs, the pubescence which is present being more slender than on other specimens of the species. However, neither of these variations is considered sufficiently distinct or significant to merit nomenclatural distinction.

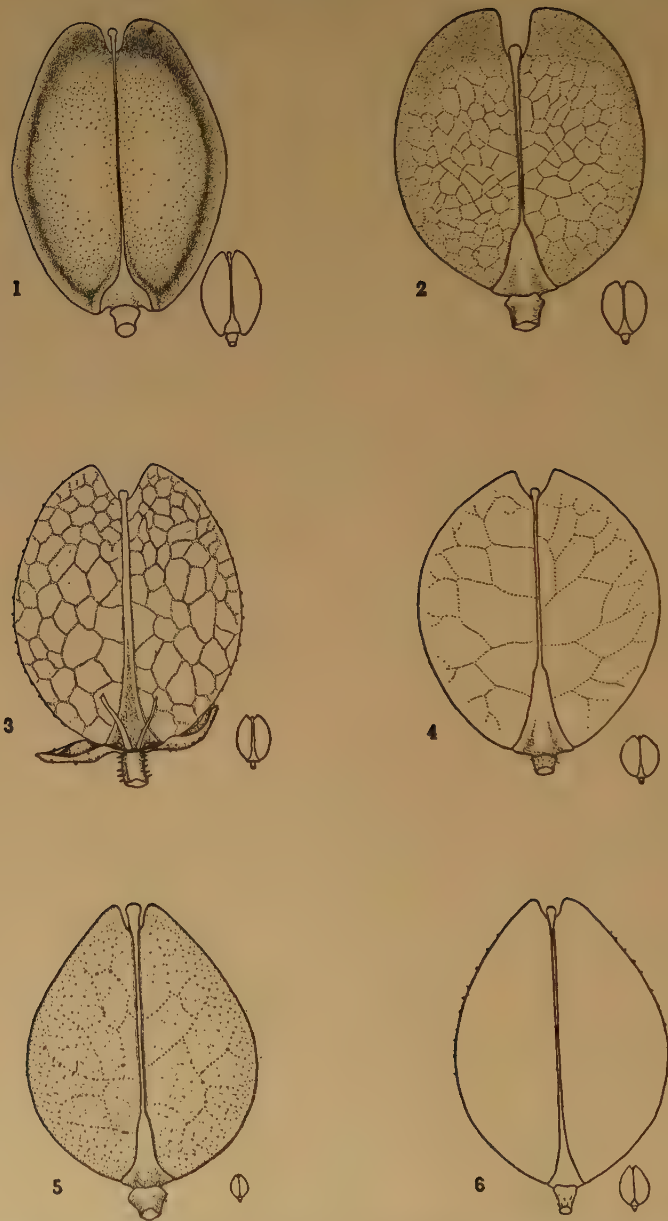

Plate XIV. United States species of *Lepidium;* upper surface of mature silicles. Small outline drawings ×2; other drawings indefinitely enlarged. Fig. 1. *L. sativum* L. Fig. 2. *L. densiflorum* Schrad. var. *Bourgeauanum* (Thell.) C. L. Hitchcock. Fig. 3. *L. pubescens* Desv. (*L. reticulatum* Howell). Fig. 4. *L. oblongum* Small. Fig. 5. *L. sordidum* Gray. Fig. 6. *L. ruderale* L. (drawn from material from Germany).

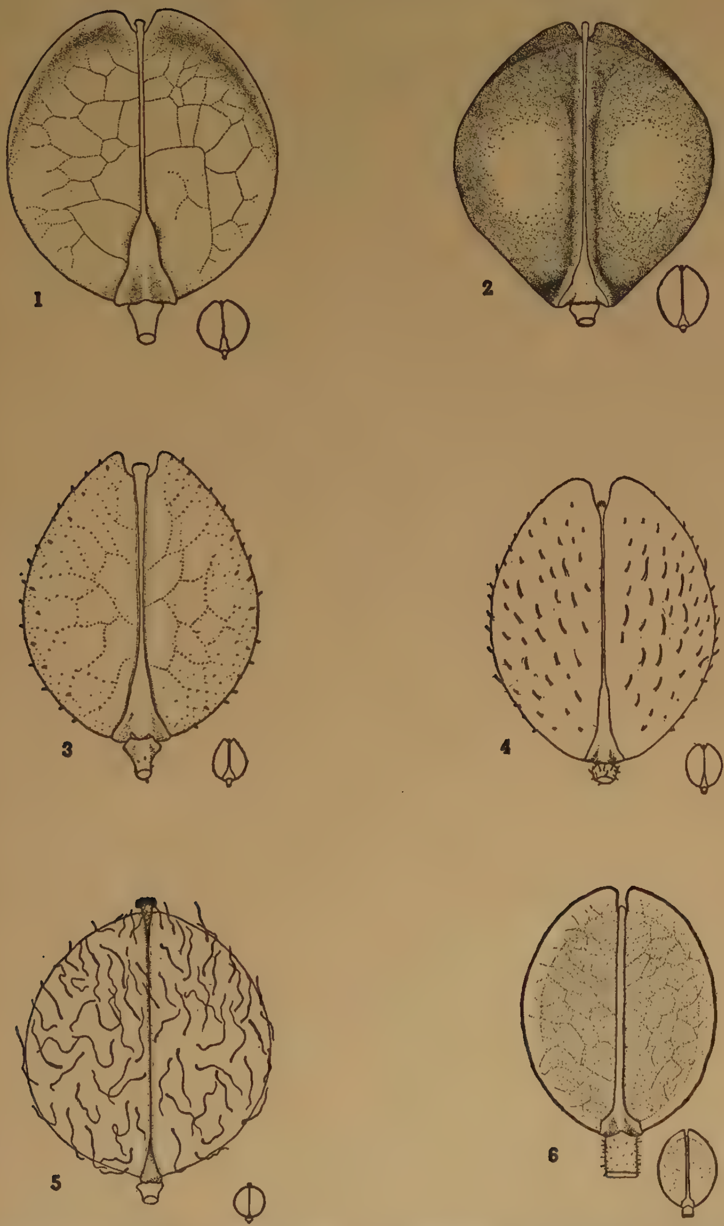

PLATE XV. United States species of *Lepidium;* upper surface of mature silicles. Small outline drawings ×2; other drawings indefinitely enlarged. Fig. 1. *L. virginicum* L. Fig. 2. *L. perfoliatum* L. Fig. 3. *L. ramosissimum* Nelson. Fig. 4. *L. austrinum* Small. Fig. 5. *L. latifolium* L. Fig. 6. *L. nitidum* Nutt.

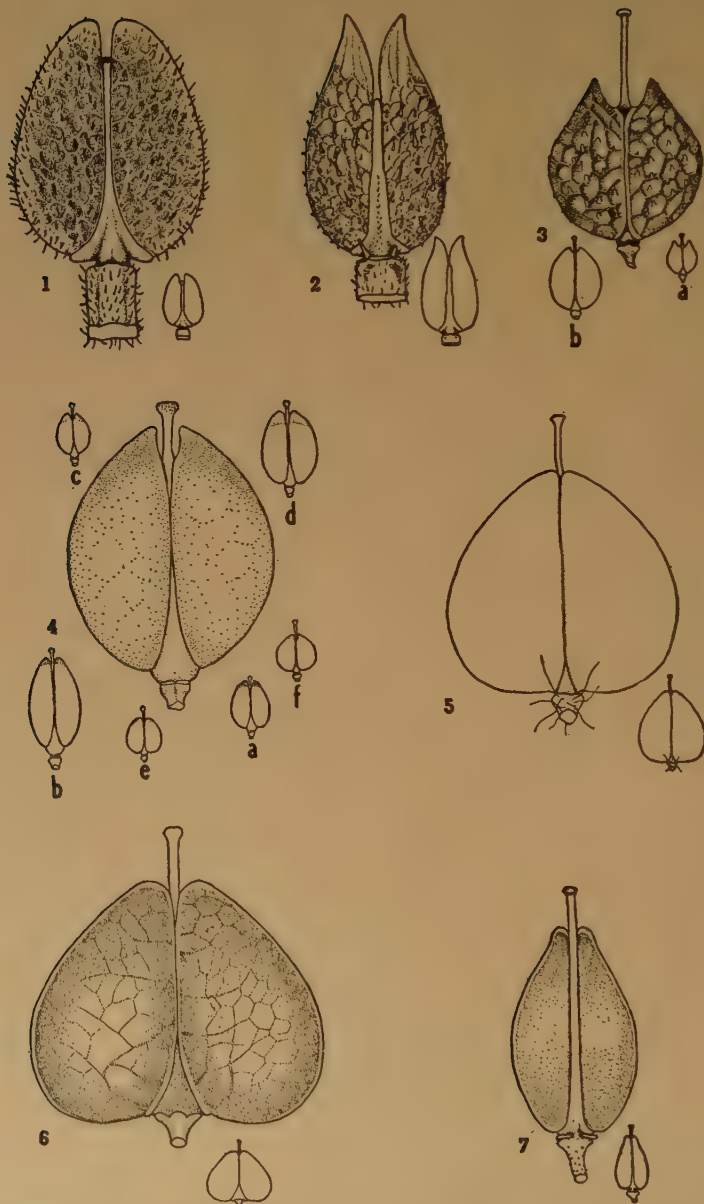

PLATE XVI. United States species of *Lepidium;* upper surface of mature silicles (except Fig. 2.). Small outline drawings ×2; other drawings indefinitely enlarged. Fig. 1. *L. dictyotum* Gray var. *typicum*. Fig. 2. *L. latipes* Hook. (lower surface). Figs. 3, 3a. *L. flavum* Torr. var. *typicum*. Fig. 3b. *L. flavum* var. *felipense* C. L. Hitchcock. Figs. 4, 4a, 4b. *L. montanum* Nutt. var. *Jonesii* (Rydb.) C. L. Hitchcock. Fig. 4c. *L. montanum* var. *typicum* f. *wyomingense* C. L. Hitchcock . Fig. 4d. *L. montanum* var. *integrifolium* (Nutt.) C. L. Hitchcock. Fig. 4e. *L. montanum* var. *canescens* (Thell.) C. L. Hitchcock. Fig. 4f. *L. montanum* var. *alpinum* Wats. Fig. 5. *L. Jaredii* Brandegee. Fig. 6. *L. Draba* L. Fig. 7. *L. nanum* Wats.

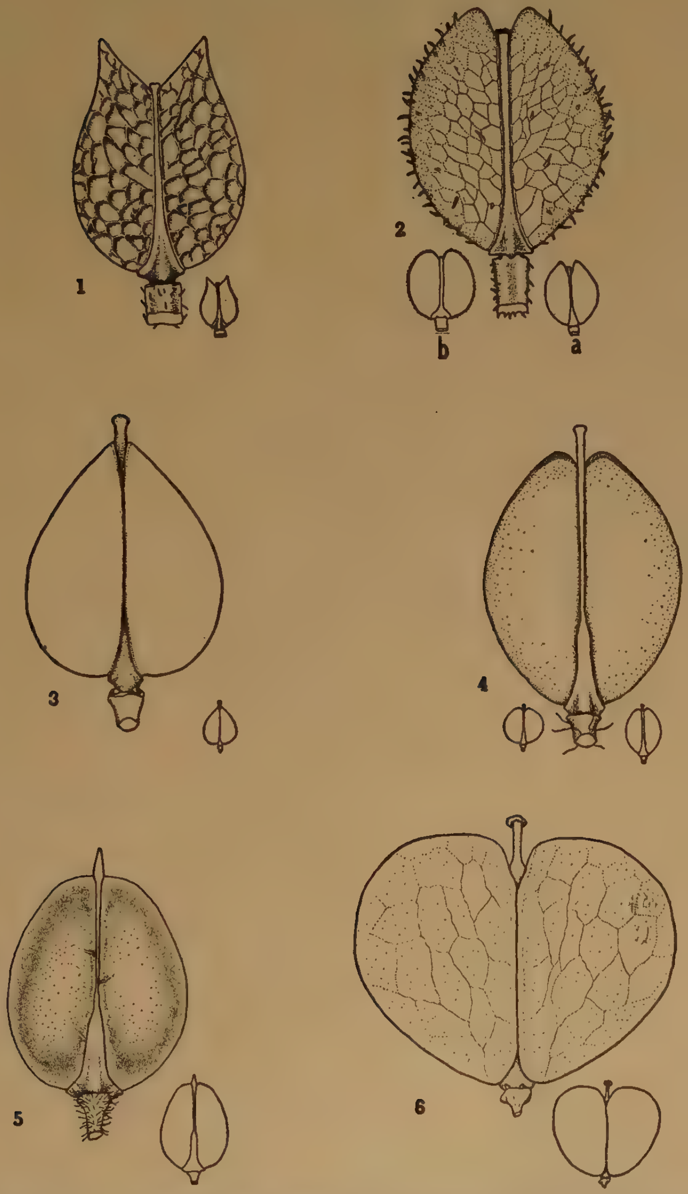

Plate XVII. United States species of *Lepidium;* upper surface of mature silicles. Small outline drawings ×2; other drawings indefinitely enlarged. Fig. 1. *L. oxycarpum* Torr. and Gray. Figs. 2, 2a. *L. lasiocarpum* Nutt. var. *typicum.* Fig. 2b. *L. lasiocarpum* var. *rotundum* C. L. Hitchcock. Fig. 3. *L. graminifolium* L. Fig. 4. *L. Thurberi* Wooton. Fig. 5. *L. campestre* (L.) R. Br. Fig. 6. *L. Fremontii* Wats.

Lepidium Thurberi can easily be distinguished from *L. montanum,* its nearest relative, by the pubescence. In the former species the hairs are plainly visible to the unaided eye as they are often 0.5–1 mm. long. Although the fruits are very similar, those of *L. Thurberi* are more nearly rhombic and the styles average shorter.

University of Montana,
Missoula, March, 1936.

VELEZIA RIGIDA IN THE SIERRA NEVADA FOOTHILLS

Charles M. Belshaw

Velezia rigida L., a low wiry annual native of the Mediterranean region, is well established in the vicinity of La Grange on warm south-facing slopes of the Tuolumne River watershed. It was collected by the writer approximately twenty-four miles northwest of La Grange, on the bank of Hunter Creek, one and one-half miles northwest of Buchanan, Tuolumne County (elevation 2300 feet, slope south 58 per cent, October 23, 1935, *Belshaw 152*). Here the species has become dominant to the exclusion of low annual grasses which usually occupy this ecological niche. A less favored habitat is open ground in woodland or chaparral.

An additional collection was made between Cool and Pilot Hill, three miles southeast of Auburn, Eldorado County (May 30, 1935, *Belshaw 945*). The species was growing in moist sandy alluvium at an elevation of 1400 feet (Upper Sonoran Zone) associated with *Quercus douglasii* H. & A. and annual grasses. No plants were seen with stems trailing.

Other known collections from California are: Humboldt Bay (without date) *H. P. Chandler;* Hupa Indian Reservation, altitude 500 feet, June, 1901, *H. P. Chandler 1306;* Supply Creek, Hupa Valley, Humboldt County, July 25, 1902, *Jepson 2120;* and Tuolumne River near La Grange, Stanislaus County, July 2, 1896, *Jepson.*

California Forest Survey,
California Forest and Range Experiment Station,
July 23, 1935.

NOTES AND NEWS

"The Genus Eriogonum, A Preliminary Study Based on Geographic Distribution" by Susan G. Stokes of San Diego High School was published privately and appeared June first. It may be obtained from Mr. J. T. Howell of the California Academy of Sciences, San Francisco. Price $2.50.

While enroute to Sonora, Mexico, for field studies, Dr. Forrest Shreve and Dr. David Keck stopped in San Diego on March second. Dr. Shreve spoke at the State College on "The Study of the Desert."

A NEGLECTED MONOGRAPH ON FOLIAR HISTOGENESIS

ADRIANCE S. FOSTER

Within recent years, an awakened interest in developmental problems, especially in connection with the theory of periclinal chimaeras, has led to a number of studies on leaf differentiation in angiosperms (5). Unfortunately, however, little or no effort has been made towards comparative investigations within a genus or family, so that most of these contributions are distinctly isolated in character. Investigators in this field have returned in vain for guidance and orientation to the classical works of anatomists of the past century, but here the emphasis was largely upon the early phases of leaf initiation, rather than upon the later stages of development. Consequently, the writer feels justified in calling attention to an unique monograph on the comparative histogenesis of leaves which has remained unnoticed by anatomists since its publication in 1872.[1] This article is from the pen of Samsøe Lund (7) and bears the title "The calyx of the Compositae: essay on the unity of development in the vegetable kingdom." The original Danish text is accompanied by a complete French translation. The extensive scope of this remarkable memoir does not permit of concise summation, but an effort will be made to indicate certain facts and conclusions which deserve consideration in the light of modern studies on leaf ontogeny.

The writer wishes to thank Dr. G. L. Stebbins, Jr., for calling his attention to Lund's monograph.

Lund maintains that, ideally, we should describe the differentiation of a leaf in terms of the formation of all its cells. However, since the practical difficulties of this goal are so great in most cases, Lund devotes the first part of his treatise to the histogenesis of a presumably simple "foliar" structure, viz., the pappus of the composite flower. In some species, for example, *Cirsium arvense*, the pappus is differentiated into an epidermal, fundamental, and vascular system. In other instances, internal tissue (which he terms "endophyll") is greatly reduced in amount or absent and the histogenesis of the pappus resembles a trichome. However, both of these extremes appear to be connected by intergrading forms and Lund concludes that the pappus is foliar in nature and, hence, a true calyx. Although Lund's morphological interpretation of the pappus may not be completely acceptable in its original form, it seems to the writer that further histogenetic studies of this structure, along comparative lines, would be extremely profitable.[2]

[1] Among the few references on this work, known to the writer, are a brief and wholly inadequate review by McNab (9) and a cursory note by Small (13).

[2] In a later paper Lund (8) defended his viewpoint against the objections of

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With the relatively simple histogenesis of the pappus as a guide, Lund next presents the results of a wide series of observations on the apical, marginal, and intercalary formation of cells in various types of foliar organs. It is significant to note, first of all, that he rejects Hanstein's (6) concept of dermatogen, periblem, and plerome, at least in respect to the apical and marginal meristems of the leaf. Lund maintains, on the contrary, that such meristems are composed at most of two regions, viz.: (a) the *pycnome,* which is formed apically or laterally as a "solid" tissue, and (b) the *périnome,* which arises apically or laterally as one or more discrete layers of cells. Thus, the pycnome is equivalent to Hanstein's plerome, while the périnome includes *both* the dermatogen and the periblem layers. Lund's viewpoint becomes decidedly modern in spirit when it is realized that more than fifty years later, Schmidt (12) adopted a similar viewpoint towards the structure of the angiospermous growing point. He classified primordial meristem into the *tunica* (= périnome) and the *corpus* (= pycnome), a distinction which has been profitably adopted by many recent investigators (cf. Foster [5], p. 352, footnote 3). In an effort to demonstrate the "unity of development," which underlies the morphogenesis of the leaves of all vascular plants, Lund states that considerable plasticity exists in the relationship and behavior of the pycnome and périnome regions of a leaf meristem. In some cases, a périnome may be absent (at least during the latter stages in development) and then marginal or apical growth resembles that of a leptosporangiate fern (cf. Bower [2]). Furthermore, the périnome, in a given organ, may change its method of cell formation and become a pycnome. Thus, Lund argues, the distinction between trichomes and phyllomes, as well as between leaf development in cryptogams and phanerogams, rests upon a quantitative, rather than a qualitative, basis. Lund defends this thesis most ably by his description of the behavior of the marginal meristem in various leaf types at successive stages in their development. His observations in this point are so pertinent to certain recent studies that a brief résumé may be of value.

The marginal meristem, which he terms the "growing line," consists, in the simplest case, of a single series of marginal initials (t_1 in figs. 43[3], 44) which by periclinal or alternating oblique divisions produce, respectively, a uniseriate or biseriate wing of tissue. This condition obtains during the final stages in growth of the involucral bracts of many composites and the bud scales of *Taxus.* More commonly, however, the marginal meristem consists of one or more layers of périnome investing a central pycnome.

Warming (14, p. 23–27) and presented additional observations on the apical growth of the pappus in *Senecio vulgaris.*

[3] Figures referred to are those of Lund's illustration, reproduced as text figure 1.

In this case, each layer of the périnome is formed by a series of marginal initials which divide by anticlinal non-convergent walls (t_1, figs. 45, 46; t_1–t_2, figs. 47, 48). The pycnome, however, is generated by a line of initials which divide either periclinally (t_2, fig. 45; t_3, fig. 47) or obliquely (t_2, fig. 46; t_3, fig. 48), thus simulating the behavior of the simple type of marginal meristem illustrated by figures 43–44.

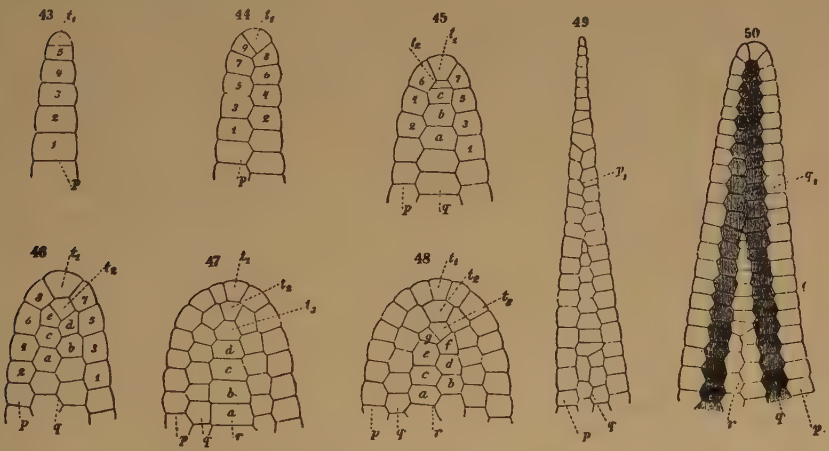

Fig. 1. Diagrams illustrating various types of marginal meristem in the foliar organs of angiosperms. The numbers or letters indicate the sequence of cell lineages. Abbreviations: *p*, outer layer of périnome; *q*, inner layer of périnome; *r*, pycnome. Further explanation in text. (From Lund.)

The distribution of these latter types of marginal meristem is interesting. The condition illustrated in figure 48 occurs in the majority of angiospermous genera investigated by Lund and the following examples may be quoted as illustrations: *Cirsium, Vinca, Cynoglossum, Viola, Vitis, Lamium, Helianthemum.* Figure 47 illustrates another frequent type which Lund observed in various species of *Rumex* and *Polygonum* and in many members of the Chenopodiaceae. A distinctive type of marginal growth is represented by figure 46, which illustrates the situation in many species of *Begonia,* as well as in some genera of the Gesneriaceae and Piperaceae. Lund carefully emphasizes the interesting fact that while some of these types of marginal growth are consistent throughout the whole course of ontogeny (e.g., figs. 47, 48), in other types the structure of the marginal meristem changes from a "high" to a "low" degree, in respect to the behavior of the initial cells as marginal growth diminishes. For example, in *Begonia,* Lund found that the pycnome at first is produced by alternating oblique divisions of the initials (fig. 46), while later these same initials divide periclinally, as is illustrated in figure 45. A more striking illustration is furnished by the bud scale of *Taxus.* Here, at first, the pycnome originates as in the *Begonia*

type (fig. 46), but later develops as is shown in figure 45. Finally, all further cell formation at the edge of the pycnome ceases and the perinome itself merges into a biseriate and ultimately uniseriate plate of cells. This complex process is clearly illustrated in figure 49. A similar transition from one type of marginal growth to another is illustrated by the development of the involucral bracts of some composites (fig. 50).

In conclusion, it may be pointed out that certain recent investigations confirm the value of Lund's provisional survey of marginal growth in the leaf. In *Carya Buckleyi* var. *arkansana* (4) and in *Heterotrichum* and *Clidemia* (15) the marginal meristem behaves similarly to the *Begonia* type as described by Lund (cf. fig. 46). The recent investigations of Cross (3) clearly show that marginal growth in the bud scales of *Morus alba* L. is identical with the situation in the cataphylls of *Taxus* as described by Lund. Although this type of marginal differentiation may prove upon further study to be characteristic of many bud scales, bracts, and sepals, it also obtains in the foliage leaves of certain monocotyledons, according to the recent studies of Pottier (11; pls. 16, 18, 35). In *Pelargonium* (10) and *Nicotiana* (1) the situation most closely resembles the type described by Lund as common to many angiosperms (cf. fig. 48), except that the "submarginal initials" are described as dividing *both* anticlinally and periclinally. Possibly, the marginal growth in *Pelargonium* and *Nicotiana* represents a condition intermediate in character between two of Lund's types. In any event, the problem of marginal growth in foliar organs demands further comparative study. It seems to the writer, however, that in all future investigations of foliar differentiation, the data and interpretations of Lund should prove a helpful source of orienation, and that his memoir should be accorded its rightful position among the anatomical classics of the nineteenth century.

University of California, Berkeley,
April 21, 1936.

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A NATURAL VIOLET HYBRID

VIOLA BRAINERD BAIRD

Viola Douglasii × purpurea hyb. nov. Planta aspectu *V. Douglasii* similis, herbae retrorso-pubescens vel canescens. Folia ambitu oblonga vel rhombico-ovata, in segmentis apiculatis, attenuatis irregulariter pinnate incisa vel divisa; stipulae foliorum basalium eis *V. Douglasii* similes, sed angustiores. Petala ut ea *V. purpurea* tincta. Pistillum ut in *V. purpureo* ovario glabro excepto. (Plate XVIII, fig. 2).

Type. Collected in Walker Basin, between Bodfish and Caliente, Kern County, Sequoia National Forest, California, altitude about 6000 feet, April 18, 1935, *Viola Brainerd Baird* (University of California Herbarium no. 545986).

The hybrid was growing with the two parent species on an open sunny hillside which was covered with *Plagiobothrys nothofulvus*. It was more vigorous than either parent. There were three plants in one cluster, one of which bore eighteen flowers and numerous buds. Further search failed to yield more material, indicating that the two species do not hybridize freely. The respective points of resemblance of the hybrid to the parent species are shown in Table I.

PLATE XVIII. Fig. 1. *Viola Douglasii* Steud. Fig. 2. *Viola Douglasii* × *purpurea* Baird. Fig. 3. *Viola purpurea* Kellogg. Specimens collected in Walker Basin, Kern County, April 18, 1935, by V. B. Baird. Drawings by F. Schuyler Matthews.

TABLE I

	V. Douglasii	*V. Douglasii* × *purpurea*	*V. purpurea*
Height	6–7.5 cm.	10–11.5 cm.	7.5–10 cm.
Pubescence	of short spreading hairs	retrorse to canescent	retrorse
Rootstock	short and stout with a cluster of strong roots	as in *V. Douglasii*	long and woody
Leaves	twice pinnately cleft into narrow linear, apiculate segments; blade 2–2.5 cm. long, green throughout	oblong to rhombic-ovate in outline, once pinnately and irregularly cleft or divided into relatively broad acute segments, apiculate and attenuate; blade as in *V. Douglasii*	oblong to rhombic-ovate, markedly dentate and attenuate; blade 2–2.5 cm. long, often purplish beneath
Radical stipule	2.5–3.2 cm. long, scarious, and wing-like, adhering under ground to the petiole, ending at the surface in a free tip	as in *V. Douglasii*, but narrower	inconspicuous or wanting
Petals	8–12 mm. long, golden yellow; back of two upper petals reddish brown	yellow as in *V. purpurea*, and reddish brown on back of two upper petals	6–10 mm. long, yellow, back of upper petals reddish-brown
Pistil	ovary glabrous, style summit head-like with hairs on the head, stigmatic aperture on the top with a small protruding lip just below	ovary glabrous, otherwise as in *V. purpurea*	ovary pubescent, style summit head-like with hairs on the sides, stigmatic aperture at the end of a tiny tilted "nose"
Cleistogamous flowers	lacking	none developed in garden transplant	abundant
Seeds	buff	none developed in garden transplant	buff-brown

Berkeley, California,
April 20, 1935.

BIBLIOGRAPHY OF THE BOTANICAL WRITINGS OF EDWARD LEE GREENE

Ellen D. Kistler

While cataloging the library of the late Dr. Edward Lee Greene,[1] which is now in the possession of the University of Notre Dame, Notre Dame, Indiana, it was found feasible to compile the following bibliography. Since this has not been done previously, it is herewith submitted to botanists in the hope that it may prove of assistance. The arrangement is chronological.

Most of the writings of Dr. Edward Lee Greene were published in journals initiated and edited by himself. The first of these, *Pittonia, a series of papers relating to botany and botanists,* appeared February 15, 1887, and ran through five volumes, the last number being issued September 9, 1905. Occasionally, articles by others appeared in the pages of *Pittonia,* but by far the larger part of the journal is from Greene's pen. *Erythea, a journal of botany, West American and general,* edited by Willis Linn Jepson and others of the Department of Botany, University of California, first appeared January 2, 1893. For two years Greene contributed freely to *Erythea,* then occasionally in 1896 and 1897. *Leaflets of botanical observation and criticism* consists of two volumes written entirely by Greene. The pages were published irregularly from November 24, 1903, to November 6, 1912. Of the journals initiated by Dr. Greene the last was *Cybele Columbiana, a series of studies in botany, chiefly North American.* Only volume I, number 1, was published. Issued in December, 1914, it contained four papers, three of which were by Greene. Of this he said on page one of the explanatory note, "Contemplating the inauguration of yet another series of botanical articles, one in which I intend to make record more fully than I did in *Pittonia,* or in the *Leaflets,* of botanical observations made out of doors, I have chosen the title given above."

It gives me great pleasure to acknowledge the assistance of Dr. David D. Keck, Division of Plant Biology, Carnegie Institution of Washington, Stanford University, California. Dr. Keck read the entire manuscript and added references which would otherwise have been omitted. I am indebted also to Dr. Theodore Just, Department of Botany, University of Notre Dame, for advice and many suggestions and to Miss Annetta Carter, University of California Herbarium, for additional references.

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113. New or noteworthy species. V. Pittonia 1: 300–303.
114. Native shrubs of California. II. Garden and Forest 2: 470–471.
115. Vegetative characters of the species of Cicuta. Pittonia 2: 1–11.
116. The genus Lythrum in California. Pittonia 2: 11–13.
117. New or noteworthy species. VI. Pittonia 2: 13–24.
118. The North American Neilliae. Pittonia 2: 25–31.
119. Geographical distribution of western Unifolia. Pittonia 2: 31–35.
120. The color character. Pittonia 2: 35–40.
121. Analogies and affinities. II. Pittonia 2: 40–50.

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123. Native shrubs of California. III. Garden and Forest 3: 198–199.
124. Analogies and affinities. III. Pittonia 2: 51–57.
125. On some North American Ranunculi. Pittonia 2: 58–65.
126. Schizonotus and Solanoa. Pittonia 2: 65–67.
127. New or noteworthy species. VII. Pittonia 2: 69–81.
128. Botanical literature, old and new. V. Pittonia 2: 91–99.
129. New or noteworthy species. VIII. Pittonia 2: 100–106.
130. Illustrations of West American oaks. From drawings by Albert Kellogg. Text by Edward L. Greene. San Francisco. 4°. pp. 51–84. Plates XXV–XXXVII.

131. The California paeonias. Garden and Forest 3: 356.
132. Native shrubs of California. IV. Garden and Forest 3: 378–379.
133. Remarks on the genus Actaea. Pittonia 2: 107–109.
134. Notes on Ranunculus. Pittonia 2: 109–111.
135. Notes on western oaks. Pittonia 2: 111–114.
136. Reprint of Fraser's Catalogue. Pittonia 2: 114–119.
137. Some genera of Rafinesque. Pittonia 2: 120–133.
138. Enumeration of the North American Loti. Pittonia 2: 133–150.
139. Revision of the genus Diplacus. Pittonia 2: 151–157.
140. New or noteworthy species. IX. Pittonia 2: 158.

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141. Flora Franciscana. An attempt to classify and describe the vascular plants of middle California. 8°. Parts 1 and 2, pp. 1–280. San Francisco.
142. Native shrubs of California. V. Garden and Forest 4: 243.
143. Are plums and cherries of one genus? Garden and Forest 4: 250.
144. Native shrubs of California. VI. Garden and Forest 4: 255–256.
145. Notes on some western cherries. Pittonia 2: 159–161.
146. New or noteworthy species. X. Pittonia 2: 161–173.
147. Some neglected priorities in generic nomenclature. Pittonia 2: 173–184.
148. Against the using of revertible generic names. Pittonia 2: 185–195.
149. On the citing of ancient botanical authors. Pittonia 2: 195–199.
150. Botanical literature, old and new. VI. Pittonia 2: 200–213.
151. A new departure in botanical nomenclature. Pittonia 2: 213–215.
152. Biolettia, a new genus of Compositae. Pittonia 2: 215–216.
153. New or noteworthy species. XI. Pittonia 2: 216–218.
154. The specific name of the Texas Cercis. Garden and Forest 4: 562–563.
155. The botanic garden. Calif. Agric. Exp. Sta. Rept. 149–150.

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158. On certain Spiraeaceae. Pittonia 2: 219–222.
159. New or noteworthy species. XII. Pittonia 2: 222–233.
160. On certain Californian Labiatae. Pittonia 2: 233–236.

161. Remarks on certain pentstemons. Pittonia 2: 237–243.
162. Studies in the Compositae. I. Pittonia 2: 244–248.
163. Notes on Brodiaea and Fritillaria. Pittonia 2: 249–251.
164. Some American Polemoniaceae. II. Pittonia 2: 251–260.
165. Teratological notes. I. Pittonia 2: 261–262.
166. Dr. Kuntze and his reviewers. Pittonia 2: 263–281.
167. New or noteworthy species. XIII. Pittonia 2: 282.
168. Native shrubs of California. VII. Garden and Forest 5: 436–437.
169. The Berlin protest. Pittonia 2: 283–287.
170. Studies in the Compositae. II. Pittonia 2: 287–290.
171. The fruit of Garrya. Pittonia 2: 292–293.
172. New or noteworthy species. XIV. Pittonia 2: 293–298.
173. The genus Kunzia. Pittonia 2: 298–299.
174. Teratological notes. II. Pittonia 2: 299–300.
175. Diagnoses of two new genera. Pittonia 2: 301–302.
176. Native shrubs of California. VIII. Garden and Forest 5: 447–448.

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177. Observations on the Compositae. I. Erythea 1: 1–4.
178. Novitates occidentales. I. Erythea 1: 4–7.
179. Review: Berthoud, Edward L. A peculiar case of plant dissemination. Erythea 1: 19–24.
180. Review: Millspaugh, C. F. Flora of West Virginia, being Bull. No. 24 of the West Virginia Agricultural Experiment Station, Morgantown, W. Va., 1892. Erythea 1: 25–26.
181. Observations on the Compositae. II. Erythea 1: 41–45.
182. Plant dispersion by the buffalo. Erythea 1: 47–48.
183. Eclogae botanicae, no. 1. Proc. Acad. Nat. Sci. Phila. 44: New or noteworthy thistles, 357–364; Three new perennial lupines, 364–365.
184. Observations on the Compositae. III. Erythea 1: 53–56.
185. [Comment on] von Mueller, F. On Jussiaea repens of Linnaeus. Erythea 1: 62.
186. Review: Huth, E. Revision der kleineren Ranunculaceen-Gattungen Myosurus, Trautvetteria, Hamadryas, Glaucidium, Hydrastis, Eranthis, Coptis, Anemonopsis, Actaea, Cimicifuga and Xanthorrhiza. Erythea 1: 70–74.
187. The vegetation of the summit of Mount Hamilton. Erythea 1: 77–97.
188. Novitates occidentales. II. Erythea 1: 105–107.
189. Corrections in nomenclature. I. Erythea 1: 114–115.
190. Review: Macmillan, C. The Metaspermae of the Minnesota Valley. Erythea 1: 117–123.
191. Novitates occidentales. III. Erythea 1: 125–128.
192. [Comment on] Holzinger, John M. The range of Amorpha fruticosa. Erythea 1: 132–133.

193. Corrections in nomenclature. II. Erythea 1: 136–138.
194. A new fashion in writing plant names. Erythea 1: 138–140.
195. Habitat of Carduus edulis. Erythea 1: 143.
196. Another bad guess at a name. Erythea 1: 143–144.
197. A second species of the genus Ramona. Erythea 1: 144.
198. Novitates occidentales. IV. Erythea 1: 147–153.
199. [Comment on] Sanders, W. A. Mentzelia affinis as a field weed. Erythea 1: 158.
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201. New honors to old weeds. Bull. Torr. Bot. Club 20: 337–338.
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203. Corrections in nomenclature. III. Erythea 1: 206–208.
204. Novitates occidentales. V. Erythea 1: 221–224.
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206. [Mohria a homonym.] Erythea 1: 236.
207. Two rare lobeliaceous plants. Erythea 1: 237–238.
208. Corrections in nomenclature. IV. Erythea 1: 246–247.
209. Novitates occidentales. VI. Erythea 1: 258–260.
210. Miscellaneous notes and news. Erythea 1: 260–261.
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212. The University Botanic Garden. Calif. Agr. Exp. Sta. Rept. 166–168.

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214. Correct nomenclature, etc. Erythea 2: 12–13.
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218. Historical notes on some Californian trees. I. Erythea 2: 43–48.
219. Sambucus coerulea Raf. Erythea 2: 52.
220. Observations on the Compositae. IV. Erythea 2: 53–60.
221. Historical notes on some Californian trees. II. Erythea 2: 64–67.

222. Jacksonia, but not Polanisia. Erythea 2: 68.
223. Observations on the Compositae. V. Erythea 2: 69–76.
224. American species of Wulfenia. Erythea 2: 80–83.
225. An editorial on some editorials. Erythea 2: 85–88.
226. Observations on the Compositae. VI. Erythea 2: 89–96.
227. Observations on the Compositae. VII. Erythea 2: 105–112.
228. Novitates occidentales. VII. Erythea 2: 119–122.
229. Novitates occidentales. VIII. Erythea 2: 181–185.
230. Novitates occidentales. IX. Erythea 2: 189–192.
231. Corrections in nomenclature. V. Erythea 2: 192–194.

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234. Novitates occidentales. X. Erythea 3: 17–24.
235. Corrections in nomenclature. VI. Erythea 3: 36.
236. Some species of Dodecatheon. Erythea 3: 37–40.
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240. Phytographic notes and amendments. I. Erythea 3: 53–57.
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242. [Comment on] Britton, N. L. [Publication by signatures]. Erythea 3: 68.
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244. Corrections in nomenclature. VII. Erythea 3: 75–76.
245. Comment of the foregoing rules. [Rules for citation, adopted by the Madison Botanical Congress and section G of the American Association for the Advancement of Science.] Erythea 3: 88.
246. Observations on the Compositae. IX. Erythea 3: 89–96.
247. Novitates occidentales. XIV. Erythea 3: 98–101.
248. Phytographic notes and amendments. II. Erythea 3: 102–105.
249. Observations on the Compositae. X. Erythea 3: 107–115.
250. Novitates occidentales. XV. Erythea 3: 118–121
251. Novitates occidentales. XVI. Erythea 3: 123–126.
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253. Dates of publication of Nuttall's Compositae. Erythea 3: 177–178.

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260. Nature of the binary name. Bot. Gaz. 21: 179–180.
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262. Nomenclature of the fullers' teasel. Pittonia 3: 1–9.
263. A proposed new genus of Cruciferae. Pittonia 3: 10–12.
264. New or noteworthy species. XV. Pittonia 3: 13–28.
265. A new genus of Polemoniaceae. Pittonia 3: 29–30.
266. Some Mexican Eupatoriaceae. Pittonia 3: 31–32.
267. Distribution of Rhamnus in America. I. Erythea 4: 83–86.
268. Critical notes on certain violets. Pittonia 3: 33–42.
269. Studies in the Compositae. III. Pittonia 3: 43–63.
270. New or noteworthy species. XVI. Pittonia 3: 86–90.
271. New western Ranunculaceae. Erythea 4: 121–123.
272. Distribution of Rhamnus in North America. II. Erythea 4: 133–136.
273. Two new Cruciferae. Erythea 4: 173–174.
274. New or noteworthy species. XVII. Pittonia 3: 91–116.
275. Studies in the Cruciferae. I. Pittonia 3: 117–138.
276. Stenophragma virgatum. Pittonia 3: 138.
277. Remarks on acaulescent violets. Pittonia 3: 139–145.
278. Studies in the Compositae. IV. Pittonia 3: 146–149.

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279. Biographical notes on American trees. I. Garden and Forest 10: 119.
280. Concerning an East American violet. Erythea 5: 39.
281. The winter hellebore, and other bibliographic notes. Pittonia 3: 151–154.
282. New or noteworthy species. XVIII. Pittonia 3: 154–172.
283. Biographical notes on American trees. II. Garden and Forest 10: 188.
284. Studies in the Compositae. V. Pittonia 3: 172–185.
285. Corrections in nomenclature. I. Pittonia 3: 186–188.
286. Ranunculaceous monotypes. Pittonia 3: 188–195.
287. New western plants. Pittonia 3: 195–198.
288. Flora Franciscana. An attempt to classify and describe the vascular plants of middle California. 8°. Part IV, pp. 353–482. San Francisco.
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290. The hop trefoils. Pittonia 3: 201–206.
291. Corrections in nomenclature. II. Pittonia 3: 207–212.
292. New or noteworthy species. XIX. Pittonia 3: 212–230.
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294. On the classification of asclepiads. Pittonia 3: 231–238.
295. The genus Chamaecrista. Pittonia 3: 238–243.
296. Studies in the Compositae. VI. Pittonia 3: 243–246.
297. New or noteworthy species. XX. Pittonia 3: 246–252.
298. Studies in the Cruciferae. II. Pittonia 3: 252–254.
299. Iodanthus dentatus. Pittonia 3: 254.
300. Notes on violets. Pittonia 3: 254–256.

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303. Studies in the Compositae. VII. Pittonia 3: 264–298.
304. New Compositae from New Mexico. Bull. Torr. Bot. Club 25: 117–124.
305. Some western Polemoniaceae. Pittonia 3: 299–305.
306. New or noteworthy species. XXII. Pittonia 3: 306–311.
307. New or noteworthy violets. Pittonia 3: 313–318.
308. Critical notes on Antennaria. Pittonia 3: 318–323.
309. The genera Polycodium and Batodendron. Pittonia 3: 323–326.
310. New species of Convolvulus. Pittonia 3: 326–333.
311. Some Canadian violets. Pittonia 3: 333–338.
312. A fascicle of new Labiatae. Pittonia 3: 338–343.
313. New or noteworthy species. XXIII. Pittonia 3: 343–349.

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314. New species of Castilleia. Pittonia 4: 1–2.
315. A fascicle of new violets. Pittonia 4: 3–9.
316. New western species of Rosa. Pittonia 4: 10–14.
317. New choripetalous exogens. Pittonia 4: 14–21.
318. Notes on Machaeranthera. Pittonia 4: 22–25.
319. Early specific types in Chamaecrista. Pittonia 4: 25–32.
320. New species of Sisyrinchium. Pittonia 4: 32–34.
321. New or noteworthy species. XXIV. Pittonia 4: 35–45.
322. Neglected generic types. I. Pittonia 4: 45–51.
323. Two new gerardias. Pittonia 4: 51–52.
324. A decade of new gutierrezias. Pittonia 4: 53–58.
325. Some western species of Xanthium. Pittonia 4: 58–63.
326. Four new violets. Pittonia 4: 64–67.
327. New or noteworthy species. XXIV [XXV]. Pittonia 4: 68–72.
328. Segregates of Caltha leptosepala. Pittonia 4: 73–81.
329. New species of Antennaria. Pittonia 4: 81–85.
330. West American Asperifoliae. IV. Pittonia 4: 86–97.
331. New or noteworthy species. XXVI. Pittonia 4: 98–101.

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332. Necker's genera of ferns. I. Pittonia 4: 103–107.
333. A fascicle of senecios. Pittonia 4: 108–124.

334. New species of Coleosanthus. Pittonia 4: 124–126.
335. A decade of new Pomaceae. Pittonia 4: 127–131.
336. A fascicle of new Papilionaceae. Pittonia 4: 132–139.
337. Notes on violets. Pittonia 4: 139–142.
338. Some new or critical Ranunculi. Pittonia 4: 142–146.
339. New or noteworthy species. XXVII. Pittonia 4: 146–158.
340. A fascicle of new arnicas. Pittonia 4: 159–174.
341. A decade of new Gentianaceae. Pittonia 4: 180–186.
342. Studies in the Cruciferae. III. Pittonia 4: 187–207.
343. Neglected generic types. II. Pittonia 4: 207–212.
344. Some Rocky Mountain asters. Pittonia 4: 212–224.
345. Corrections in nomenclature. III. Pittonia 4: 224–226.

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346. Taraxacum in North America. Pittonia 4: 227–233.
347. New or noteworthy species. XXVIII. Pittonia 4: 233–241.
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352. New plants from Alberta. Ottawa Nat. 15: 42.
353. Some literary aspects of American botany. II. Catholic Univ. Bull. 7: 295–303.
354. Some neglected violets. Pittonia 4: 285–297.
355. New species of Cerastium. Pittonia 4: 297–304.
356. Five new species of Rumex. Pittonia 4: 304–306.
357. Corrections in nomenclature. IV. Pittonia 4: 307.
358. Studies in the Cruciferae. IV. Pittonia 4: 307–315.
359. New species of Laciniaria. Pittonia 4: 315–318.
360. New or noteworthy species. XXIX. Pittonia 4: 318–320.
361. New species of Monardella. Pittonia 4: 321–322.
362. Certain Canadian violets. Ottawa Nat. 15: 191–192.

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364. Some new northwestern Compositae. Ottawa Nat. 15: 278–282.
365. Two new erigerons. Bull. So. Calif. Acad. Sci. 1: 39.
366. Five new Ranunculi. Ottawa Nat. 16: 32–34.
367. New northwestern plants. Ottawa Nat. 16: 35–39.
368. New or critical species of Acer. Pittonia 5: 1–4.
368a. A new study of Microseris. Pittonia 5: 4–16.
369. Some Phacelia segregates. Pittonia 5: 17–23.
370. Segregates of Viola canadensis. Pittonia 5: 24–29.
371. Some new acaulescent violets. Pittonia 5: 29–34.
372. Revision of Romanzoffia. Pittonia 5: 34–42.
373. Revision of Capnorea. Pittonia 5: 42–52.
374. New species of Cryptanthe. Pittonia 5: 53–55.
375. A fascicle of new Compositae. Pittonia 5: 55–64.

376. New species of Apocynum. Pittonia 5: 64–66.
377. New species of Eriogonum. Pittonia 5: 67–71.
378. A study of Euthamia. Pittonia 5: 72–80.
379. New species of Monardella. Pittonia 5: 80–87.
380. New or noteworthy violets. Pittonia 5: 87–106.

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381. New or noteworthy species. XXX. Pittonia 5:107–114.
382. The genus Viola in Minnesota. I. Pittonia 5: 115–133.
383. Novitates Texanae. I. Pittonia 5: 133–139.
384. Platystemon and its allies. Pittonia 5: 139–194.
385. Three new Ranunculi. Pittonia 5: 194–197.
386. New species of Polygonum. Pittonia 5: 197–203.
387. Distribution of Bidens vulgata. Leaflets Bot. Obs. and Crit. 1: 1.
388. A new southern violet. Leaflets Bot. Obs. and Crit. 1: 2–4.
389. In the wrong genus. Leaflets Bot. Obs. and Crit. 1: 4.
390. Further segregates from Aster. Leaflets Bot. Obs. and Crit. 1: 4–7.
391. Neglected eupatoriaceous genera. Leaflets Bot. Obs. and Crit. 1: 7–13.
392. The logic of it. Leaflets Bot. Obs. and Crit. 1: 14–16.

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394. Some Canadian antennarias. I. Ottawa Nat. 17: 201–203. (Reprinted in Fedde, Rep. Spec. Nov. 6: 162–164. 1908.)
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397. North American species of Amarella. Leaflets Bot. Obs. and Crit. 1: 53–56.
398. Seven new apocynums. Leaflets Bot. Obs. and Crit. 1: 56–59.
399. Affinities of the Cichoriaceae. Leaflets Bot. Obs. and Crit. 1: 59–63.
400. Some western buckthorns. Leaflets Bot. Obs. and Crit. 1: 63–65.
401. A name explained. Torreya 4: 173–174.
402. New species of Ceanothus. Leaflets Bot. Obs. and Crit. 1: 65–68.
403. The genus Pneumonanthe. Leaflets Bot. Obs. and Crit. 1: 68–71.
404. A rare Swertia. Leaflets Bot. Obs. and Crit. 1: 72.
405. New plants from middle California. Leaflets Bot. Obs. and Crit. 1: 73–81.
406. Certain West American Cruciferae. Leaflets Bot. Obs. and Crit. 1: 81–90.

407. Laothoë. Leaflets Bot. Obs. and Crit. 1: 90–91.
408. On certain Gentianaceae. Leaflets Bot. Obs. and Crit. 1: 91–95.
409. Two new Batrachia. Leaflets Bot. Obs. and Crit. 1: 95–96.
410. Two new Sophiae. Leaflets Bot. Obs. and Crit. 1: 96.

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411. Diagnoses Aragallorum. Proc. Biol. Soc. Wash. 18: 11–17.
412. Some West American red cherries. Proc. Biol. Soc. Wash. 18: 55–60.
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414. Revision of Eschscholtzia. Pittonia 5: 205–293.
415. A new papaveraceous genus. Pittonia 5: 293–294.
416. A study of Dendromecon. Pittonia 5: 295–306.
417. Suggestions regarding Sanguinaria. Pittonia 5: 306–308.
418. Some Ptelea segregates. Torreya 5: 99–100.
419. Derivation of the name Chamaechrista. Torreya 5: 126–128.
420. Extension of Osmaronia. Pittonia 5: 309–312.
421. Latin as the language of botanical diagnosis. Science, n. s. 22: 338–340.
422. Origin of Rhus bipinnata. Torreya 5: 155–157.
423. A proposed new genus, Anotites. Leaflets Bot. Obs. and Crit. 1: 97–105.
424. Some New England persicarias. Leaflets Bot. Obs. and Crit. 1: 105–110.
425. What is Nuttallia Davidiana? Leaflets Bot. Obs. and Crit. 1: 110–111.
426. Three new heucheras. Leaflets Bot. Obs. and Crit. 1: 111–112.
427. The genus Radicula. Leaflets Bot. Obs. and Crit. 1: 113–114.
428. Segregates of the genus Rhus. Leaflets Bot. Obs. and Crit. 1: 114–144.
429. On so-called Silene Menziesii. Ottawa Nat. 19: 163–166.
430. New plants from southwestern mountains. Leaflets Bot. Obs. and Crit. 1: 145–154.
431. Atasites and Thyrsanthema. Leaflets Bot. Obs. and Crit. 1: 154–158.
432. New species of Chaptalia. Leaflets Bot. Obs. and Crit. 1: 158.
433. A proposed new genus, Callisteris. Leaflets Bot. Obs. and Crit. 1: 159–160.

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434. New species of Pentstemon. Leaflets Bot. Obs. and Crit. 1: 161–167.
435. Madronella. Leaflets Bot. Obs. and Crit. 1: 168–169.

436. New species of Isocoma. Leaflets Bot. Obs. and Crit. 1: 169–173.
437. New asteraceous genera. Leaflets Bot. Obs. and Crit. 1: 173–174.
438. Segregates from Sieversia. Leaflets Bot. Obs. and Crit. 1: 174–179.
439. Various new species. Leaflets Bot. Obs. and Crit. 1: 180–182.
440. Mutations in Viola. Leaflets Bot. Obs. and Crit. 1: 182–187.
441. The genus Tridophyllum. Leaflets Bot. Obs. and Crit. 1: 188–189.
442. New species of Mimulus. Leaflets Bot. Obs. and Crit. 1: 189–190.
443. A further study of Chaptalia. Leaflets Bot. Obs. and Crit. 1: 190–197.
444. Icianthus and Sprengeria. Leaflets Bot. Obs. and Crit. 1: 197–199.
445. New or noteworthy species. Leaflets Bot. Obs. and Crit. 1: 199–200.
446. An unwritten law of nomenclature. Leaflets Bot. Obs. and Crit. 1: 201–205.
447. Certain malvaeous types. Leaflets Bot. Obs. and Crit. 1: 205–209.
448. The genus Nuttallia. Leaflets Bot. Obs. and Crit. 1: 209–210.
449. The genus Bossekia. Leaflets Bot. Obs. and Crit. 1: 210–211.
450. New plants from New Mexico. Leaflets Bot. Obs. and Crit. 1: 211–214.
451. New species of Viola. Leaflets Bot. Obs. and Crit. 1: 214–219.
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University of Notre Dame,
Notre Dame, Indiana,
January 21, 1936.

GROWTH HABITS OF BARREL CACTI

Robert R. Humphrey

Most desert perennials while in the seedling stage grow in definitely mesophytic situations. As they mature, however, most of them develop under xerophytic conditions, and seem to carry little or no impress of the more humid conditions requisite for germination and early survival. The barrel cacti, or bisnagas (*Echinocactus Wislizeni* Engelmann), as observed within a fifty mile radius of Tucson, Arizona, are striking examples of plants which, though fully exposed to the arid climate when mature, still retain the impress of seedling requirements. Indeed, the excessive development of this early tendency often results in the death of the plants.

For those unacquainted with these interesting cacti a brief description is given. A mature bisnaga is characteristically barrel-shaped and one to four feet high. Individuals much taller than four feet are uncommon, although they may occasionally grow to twice this height. As shown in text figure 1, mature bisnagas are strongly ribbed by a series of vertical ridges which extend the length of the plant and which converge at the growing point at the top. Groups of spines occur at rather regular intervals on each rib. The four central spines of each group are very heavy and strongly hooked downward. A dense circle of orange-red flowers, which persist until late in summer, appears near the center of the top during the summer rains. The yellow,

Fig. 1. *Echinocactus Wislizeni* Engelmann. An unusually large specimen overtopping the vegetation that formerly sheltered it.

rather ornamental fruits may remain on the plant for more than a year.

Bisnagas occur in the greatest numbers on gently sloping *bajadas,* or outwash plains, at the base of scattered mountain ranges, but unlike the sahuaros (*Carnegiea gigantea*) they sometimes occur also on fine alluvial adobe clays of river bottoms.

Wooton and Standley[1] give the range of the species as "Utah and Arizona to western Texas and northwestern New Mexico." It occurs abundantly throughout parts of southern Arizona, including the vicinity of Tucson, below an elevation of 4,500 feet.

In common with such other cacti as the sahuaros and to a certain extent some of the smaller subglobose forms of *Neomamillaria,* bisnaga seedlings seem to establish themselves best under more or less protection during the years that immediately follow germination. It is exceptional for an individual to reach maturity without having had some sort of shelter during the first years of growth. Although this shelter is most commonly afforded by some other kind of vegetation, a rock or similar object may also serve. Shreve[2] has shown that conditions for seedling survival are more favorable in the shade of vegetation than in the open. Possibly such shelter explains the survival of bisnaga seedlings, and the absence of protection may account for the comparatively few that seem to have survived when exposed to the full rays of the sun.

[1] Wooton, E. O., and Stanley, P. C. Flora of New Mexico. Contr. U. S. Nat. Herb. 19: 1915.

[2] Shreve, F. Physical conditions in sun and shade. Ecology 12: 92–104. 1931.

There seems to be an early tendency for a young bisnaga to orient itself toward the sun, or, if the protecting vegetation will not allow this, at least toward the best light available. Apparently this results in the plant's assuming a leaning position from which, even after overtopping the protecting vegetation, it rarely completely recovers (plate XIX, fig. 2). Usually the angle of inclination tends to become greater as the years pass. Although the direction of leaning is usually toward the southwest, sometimes it is in other directions.

Two alternative theories are commonly given to explain the leaning position of the bisnagas. (1) Greater transpiration of the tissues on the warmer southern side of the plants may cause a contraction of the cells on this side. Were there such a tissue shrinkage, it would seem that these plants would assume the shape of an arc, inasmuch as each cell on the southern side would be somewhat shorter than the corresponding cell on the opposite side. But the plants are not curved. They tend to grow straight even though they may lean very markedly. At times, indeed, there may be a curvature in the opposite direction from the general inclination of the plant. An example of this may be seen at the base of the individual shown in text figure 1. (2) The other explanation is that fewer cells are formed on the southern side as the result of unfavorable growth conditions. Were this the case, a plant would become arc-shaped. As shown in figure 2, (plate XIX) unless the direction of growth is abnormally interfered with, each plant tends to grow approximately straight in the same general direction assumed in the seedling stage. As the cactus grows larger and heavier the strain on the rather weak root system increases and the inclination becomes more pronounced until finally the plant is uprooted by its own weight (plate XIX, fig. 1).

Some mature bisnagas occur in the open, but these individuals are usually growing in a leaning position. Since the seedlings grow almost invariably under shelter of some sort and since careful examination of these "open" bisnagas commonly reveals traces of former protecting vegetation, it may be assumed that such individuals have outlived the plants under whose protection they formerly grew. Thus when seeds germinate under such half-shrubs as burro weeds (*Aplopappus fruticosus*) or burro bushes (*Franseria deltoidea*), these apparently shorter lived plants usually die in the course of a few years, leaving the bisnagas standing alone. In those observed instances where the barrel cacti have become established under long lived trees, such as mesquites (*Prosopis* spp.) or palo verdes (*Cercidium* spp.), they usually grow to maturity without any apparent effect on the sheltering trees.

Summary. Seedlings of the barrel cactus commonly become established in the shade cast by other vegetation. As the seed-

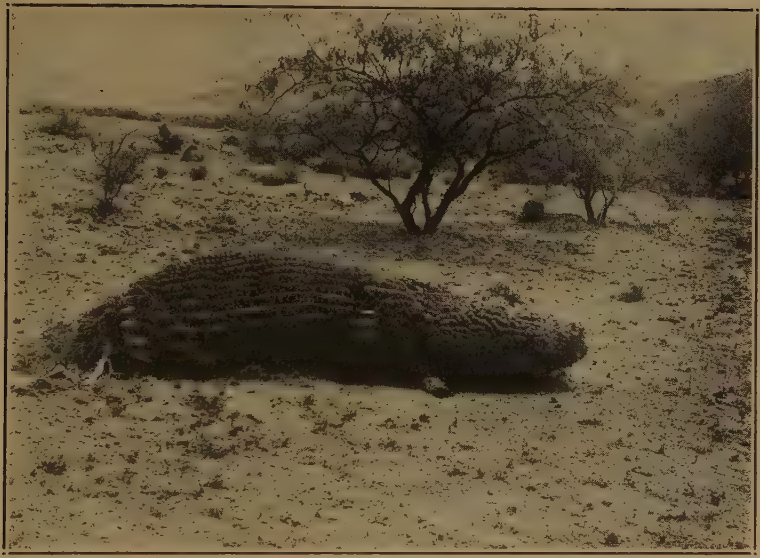

FIGURE 1

FIGURE 2

PLATE XIX. ECHINOCACTUS WISLIZENI ENGELMANN. Fig. 1. A mature specimen uprooted from an inclining position by its own weight. Fig. 2. A typical specimen growing in the shade of a mesquite. Note the pronounced inclination toward the light.

lings grow, they exhibit a tendency to lean toward the most intense light available. This early leaning habit usually persists throughout the life of the plants and, because of the strain thus put upon the root system, often results in their ultimate uprooting and death.

Southwestern Forest and Range Experiment Station,
United States Forest Service,
Tucson, Arizona, March 9, 1936.

THE RELATION OF BIRDS TO SEED DISPERSAL OF THE DESERT MISTLETOE

R. B. Cowles

Although the especially interesting relationship of birds to the dispersal of seeds of some of the Loranthaceae has been mentioned frequently, it may not be amiss to restate this role in connection with the dispersal of the parasite *Phoradendron californicum,* and also to record a few original observations.

A number of species of birds have been observed feeding on the fruit of the desert mistletoe. Any bird which even occasionally feeds upon the fruit would, to a greater or less degree, be involved in its dispersal. The most important bird would seem to be the silky flycatcher, *Phainopepla nitens,* which most obviously bears a close association to mistletoe dispersal. Other birds observed feeding on mistletoe are the western bluebird, western robin, and desert quail. To this list could be added the linnet, mocking-bird, sage and other thrashers, audubon warbler, and many other less important species. Probably a careful check upon feeding habits of many of the non-resident birds present in the desert during the winter months would show interesting results. It seems obvious that frugivorus birds and the insectivorous species which resort to fruit upon occasions when other food is not available, would find in *Phoradendron* an easily accessible emergency supply with which to eke out the scanty fare available in the desert during the winter months. As an emergency food supply or as a sole source of subsistence, the mistletoe offers an unique advantage to avian life on the desert. Unlike many of the desert products which are dry, bitter or pungent, the mistletoe provides a moderately juicy fruit free from the usual repellents found in desert plants, and one which is most remarkable for the long period during which it is available to desert fauna.

During April, 1935, while on a visit to Borego Valley, San Diego County, California, it was observed that the season's crop of berries was just ending, and at the same locality in November, 1935, the first fruit of the new season was just ripening. Apparently then, there is a period of six months when the berries are

available somewhere in any region where the mistletoe is abundant. It is true that at some time during this period, much of the mistletoe is in bloom, but at the same time many clusters are fruiting. This extended fruiting period is exceptional and is especially noteworthy in desert areas where in general fruiting seems to occur over only a short period. The method of seed dispersal of this important avian food crop would seem to be so effective as to make unnecessary the obviously enormous output of seeds.

Predicated on the usual basis of fecundity versus nurture, one would assume from the apparent abundance of seeds that their dispersal and placement would be poor. If, however, one observes the methods of dispersal and the effectiveness with which the seeds are spread about and attached to likely hosts, one can only assume that the percentage of survival must be low. Otherwise, production of seed would not be so great.

As a matter of fact, most of the very large crop of seed appears to be fertile. Certainly enormous numbers are successfully placed on the surface of living twigs of the host plant, yet only a very small proportion of the seeds which germinate ever succeed in continuing growth and becoming adult parasites. Practically all which fall upon living or even dead twigs germinate, as can be seen by even a casual scrutiny of the seeds found attached to the host. Because of its size and color the bright brownish-red radicle is conspicuous. Since most of the seeds appear to be fertile, and since germination and production of an attaching radicle seem almost universal, an explanation of the large seed production would appear to lie elsewhere than in nurture.

One serious loss of seeds is due probably to the common habit of many species of birds of perching on dead twigs, high above the rest of the tree. It has been noticed, for instance, that soon after feeding, bluebirds, and that most important distributor of seeds, the silky flycatcher, resort to the bare, topmost twigs in the immediate neighborhood of the feeding station. Most of these favorite perches are located over masses of dry twigs, apparently killed by an earlier mistletoe infestation. This habit of many birds, but especially of *Phainopepla,* has perhaps two interesting possibilities: many discharged seeds fall either on a dead twig (pl. XX, fig. 2) where they germinate in vain, or accumulate in piles (pl. XX, fig. 1) where apparently many fail to germinate. In either case, this perching habit of the carrier of the parasite results in a loss of a large number of seeds. It should be noted, however, that the same habit may have a favorable effcct on the dispersal of the mistletoe. The very fact that the birds fly from the cluster of an established plant and seek out some other perch is important for dispersal, since through this habit there is an

increased exposure of other hosts to the infection. This trait may be effective also, provided that individual trees of the host plant vary in their resistance to the inroads of the germinating seed. Judging from the presence of parasite-free trees and of trees apparently killed by *Phoradendron,* this variation probably exists. Therefore, dying or dead twigs in a weakened tree by providing an invitation to birds, give an opportunity for reinfecting a host with fresh stock or for infecting weakened trees which may be subject to attack.

It is probable that trees vary considerably in their powers of resistance to these inroads. Some of the younger trees may be individually more resistant than others of the same age, but in general it is probable that older, time-weakened trees with bare, inviting twigs become most heavily infected.

That escape from the inroads of the parasite does not lie in chance alone is evident when the germinating seeds are studied in March and April, especially in the Colorado Lower Sonoran Zone, where at this particular time, they are still attached to the ironwood host. It will be noted that almost all the seeds have been pushed away from the intended host by a gum exudate which is produced by it (pl. XX, fig. 4). While the radicle of the seed may remain attached for a time, the constantly exuding and hardening gum eventually breaks connections between radicle and host, and the seedling dies. Within a short time this pillar of dry gum becomes brittle and breaks off. The radicle, even if by some chance it is still attached to the host, together with the remaining portion of the seed, is carried to the ground.

The question naturally arises as to what other factors are involved in the destruction of seeds, either through direct agencies as described, or through less evident means. Among the more obvious direct factors might be classed rodent action. It is well known that most rodents are voracious seed eaters and this seems to be particularly true of desert species. It is also true apparently, especially on the desert, that almost any nourishing organic matter may be utilized by these animals. It would, therefore, be expected that they would harvest those seeds which are distributed on the ground and also those dispersed along the twigs, thus protecting the tree from the inroads of the parasite.

After a careful examination of trees on which there was an abundant supply of attached seeds of the mistletoe, it became obvious that the few arboreal rodents present in the area do not consider these seeds an attractive food. Otherwise it is unlikely that there should be such accumulation as was found under *Phainopepla* perches. If rodents act as protectors of the host plant, it is probably purely incidental and due to their crawling along the branches in search of ironwood seeds and seedpods, or to obtain bark, twigs, and leaves. It may be, however, that

Plate XX. Phoradendron californicum on Olneya tesota. Fig. 1. Accumulated seeds on dead branch; deposited as feces of *Phainopepla*. Fig. 2. Seeds attached to dead twig; note radicle. Fig. 3. Seed attached to living twig. Fig. 4. Seed separated from twig by gummy exudate. Fig. 5. Newly established plant.

since they find ironwood bark to their liking, the gummy exudate present under the upraised seeds is also attractive to them. If this is true, their activity in searching out and collecting the gum might be serviceable to the tree, since it would be highly effective in breaking loose both seed and radicle. This possibility of rodent activity in conjunction with seeds is at present, however, purely conjectural. It may be of interest to note that a white rat found the seeds very distasteful, even though they had been macerated and combined with egg yolk.

An interesting study in the relative effectiveness of birds in the distribution of mistletoe is available to residents in desert areas where the parasite exists. This effectiveness would depend on three factors: use of the fruit for food; abundance of the species; habits of the species, that is, behavior subsequent to eating the fruit.

In the following comment the birds are mentioned in the probable order of their importance as distributors of mistletoe seed in Borego Valley. *Phainopepla,* a voracious feeder on mistletoe, is the most abundant species feeding on the plant. Furthermore, its perching habits are adapted most admirably to the role of seed distributor. Bluebirds feed on the fruit of the mistletoe and are moderately abundant during the fruiting winter months; their perching habits facilitate the dispersal of seed. Desert quail feed on the fruit voraciously. They are abundant throughout the fruiting period, but after eating, they return to the ground so are less important as effective distributors. Moreover, during feeding, these birds knock off large numbers of berries and frequently break loose whole twigs. In addition to these species which are most important in the economy of the parasite, others such as robins and thrashers might be mentioned but upon these few observations are available. Until continuous and more careful observations are made, any statement as to the value of many of the birds to the mistletoe would be purely conjectural.

University of California, Los Angeles,
April 6, 1936

PLANTS DESCRIBED ORIGINALLY FROM CRATER LAKE NATIONAL PARK

F. Lyle Wynd

The following is a list of the plants known to have been described originally from Crater Lake National Park. The author studied these plants during several seasons at the Park.

Botrychium pumicola Coville, Underw. Nat. Ferns, ed. 6. 69. 1900. Growing in pumice soil on the summit of Llao Rock, Crater Lake, Oregon, at an elevation of about 9000 feet, *Coville*

and Applegate, 1898. A very rare plant, known only from the type locality. The vernation is erect in the sterile segment, the stems sheathed with remnants of earlier growth.

Scirpus Congdoni Britton var. minor Henderson, Rhodora 32: 21. 1930. Along a creek, Mackenzie Pass, Oregon, *Henderson 7108;* Pole Bridge Creek, Crater Lake Park, *Wynd 1769.* Known only from the type locality and from Crater Lake Park. The variety differs from the species in its lower stature, and shorter rays.

Carex campylocarpa Holm, Am. Jour. Sci. ser. 4, 20: 304. Figs. 13–15. 1905. Crater Lake National Park, Cathedral Spring, *Coville 1457.* This species resembles *C. scopulorum,* but differs in having distinct marginal denticulations on the perigynium and a more slender habit. It is found in the mountains of western Washington and Oregon.

Silene montana Wats. var. viscida Henderson, Rhodora 32: 25. 1930. Dry woods, Crater Lake Park, Oregon, in high Canadian Zone, *Wynd 2357.* The variety differs from the species in being finely glandular. Known only from Crater Lake Park, where it is common throughout the Canadian Zone.

Arenaria pumicola Coville and Leiberg, Proc. Biol. Soc. Wash. 11: 169. 1897. Crater Lake, Oregon, at an altitude of 2180 meters, *Coville and Leiberg 349.* This plant is very similar to *A. aculeata* Wats. and is doubtfully consistently separable from it. In general, Crater Lake material has the leaves more erect and either blunt or very short-pointed, while those of *A. aculeata* Wats. are definitely sharp-pointed. The nerves of the calyx are less pronounced in the Crater Lake form. Very common at Crater Lake. Its range, as represented by specimens in the United States National Herbarium, extends through northeastern California.

Ranunculus Gormani Greene, Pittonia 3: 91. 1896. On moist banks at Cathedral Springs, Crater Lake, August 22, 1896, *Gorman.* This plant has been collected in the mountains from the Three Sisters in Oregon to the Klamath Mountains in California. It is a small creeping species, common in wet places.

Ranunculus terrestris Wynd, Torreya 30: 53. 1930. Red Blanket Creek, in the southwest corner of Crater Lake National Park, *Wynd 2086.* This form is to be included in *R. Gormani* Greene as a synonym.

Ranunculus occidentalis Nutt. var. dissectus Henderson, Rhodora 32: 25. 1930. Near Pole Bridge Creek, dry slopes of Crater Lake Park, Oregon, *Wynd 2221.* The variety has deeply cleft to divided radical leaves. Material has also been collected in Klamath, Cook, and Lake counties, Oregon.

Cardamine bellidifolia L. var. pachyphylla Coville and Leiberg, Proc. Biol. Soc. Wash. 11: 170. 1897. Crater Lake, Mount Mazama, Oregon, at an altitude of 2300 meters, *Coville and Leiberg 426*. The variety occupies a range geographically contiguous to the western arm of the southern montane extension of the circumpolar species, namely the Cascade Mountains of southern Oregon and northern California.

Arabis Wyndii Henderson, Rhodora 32: 25. 1930. Crater Lake Park, Oregon, *Wynd 2322*. This plant resembles *A. pulchra* Jones, but differs in having furcate hairs toward the base of the plant. The upper part of the stem and the leaves are glabrous, the leaves ciliate; the capsules are glabrous. Western botanists have referred this species to *A. hastulata* Greene and to *A. Holboellii* Hornem. It is especially common in the yellow pine forests of Crater Lake Park and about the Klamath Lakes.

Arabis horizontalis Greene, Leaflets Bot. Obs. and Crit. 2: 74. 1910. Crater Lake, Klamath County, Oregon, *Coville and Applegate 334*. This species is a synonym of *A. Lemmoni* Wats.

Arabis dianthifolia Greene, Leaflets Bot. Obs. and Crit. 2: 76. 1910. Crater Lake Park, southern Oregon, *Coville 1511*. This is a synonym of *A. suffrutescens* Wats.

Ribes erythrocarpum Coville and Leiberg, Proc. Biol. Soc. Wash. 10: 132. 1896. At an altitude of about 1675 meters, in the canyon of Pole Bridge Creek, about ten kilometers south of Crater Lake, Cascade Mountains, Oregon, August 12, 1896, *Coville and Leiberg*. A very distinct species, separable from *R. laxiflorum* Pursh and *R. Howellii* Greene by its creeping habit and its glandular pubescence. This is one of the most characteristic and beautiful plants of the Hudsonian Zone. Its distribution, as indicated by specimens in the United States National Herbarium, extends only through the Park and its immediate vicinity.

Lupinus Lyallii Gray var. fruticulosus (Greene) C. P. Smith, Bull. Torr. Bot. Club 51: 303. 1924. *L. fruticulosus* Greene, Muhlenbergia 8: 117. 1912. Klamath County, southern Oregon, Annie Creek Valley, July 31, 1897, *Coville and Applegate*. This is the most robust variety of the species, resembling *L. aridus* Dougl. It has relatively large flowers and a broad banner. Its range extends through Jackson and Klamath counties, Oregon.

Oxypolis occidentalis Coulter and Rose, Contr. U. S. Nat. Herb. 7: 196. 1900. In springy meadows west of Crater Lake, Oregon, altitude 1870 meters, *Leiberg 4413*. This species resembles *O. Fendleri* (Gray) Heller, but is more robust. It is common at Crater Lake about springy places, and is found also in the Sierra Nevada Mountains of California from Tuolumne County to Tulare County.

COLLOMIA MAZAMA Coville, Proc. Biol. Soc. Wash. 11: 35. 1897. Near Crater Lake, in the Cascade Mountains of Oregon, at an altitude of 1900 meters, *Coville and Leiberg 429*. A beautiful, blue-flowered species, especially common in the swampy meadows along the western boundary of the Park. It is known only from Crater Lake Park and from Jackson County, Oregon.

CASTILLEJA APPLEGATEI Fernald, Erythea 6: 49. 1898. Summit of Mount Scott (2800 meters), Klamath County, Oregon, *Applegate 87*. The corolla is nearly three centimeters long. The galea is greenish-backed, with its upper three-fourths exserted. A handsome species known only from the Park and its immediate vicinity.

SAMBUCUS LEIOSPERMA Leiberg, Proc. Biol. Soc. Wash. 11: 40. 1897. Crater Lake, Oregon, altitude 2230 meters, *Coville and Leiberg 370*. This species is a synonym of *S. racemosa* L.

MACHAERANTHERA INOPS Nelson and Macbride, Bot. Gaz. 62: 148. 1916. On Glacier Mountain [GlacierPeak?], Oregon, in the Crater Lake region, *Walpole 2288*. A depauperate rayless perennial with fuscous pappus. The involucral bracts are minutely pubescent, obscurely or not at all glandular, linear-oblong, subacute, with some of the tips refracted. This species is known only from the type locality and its vicinity.

MACHAERANTHERA INOPS Nelson and Macbride var. ATRATA Nelson and Macbride, Bot. Gaz. 62: 148. 1916. Crater Lake Park, on firm pumice gravel at the summit of Llao Rock, *Coville 1470*. The variety is like the species except that it has fewer stems and fewer but larger heads. The involucres are broadly turbinate rather than hemispherical, the bracts having either dark-purple striations or margins.

Henry Shaw School of Botany,
Washington University,
St. Louis, Missouri,
March 11, 1936.

NOTES ON ARABIS L.

REED C. ROLLINS

In the course of a study of the genus *Arabis* as it occurs naturally in the Pacific Northwest, it has frequently been necessary to consider material from adjacent areas. In doing so several items involving the change of specific or varietal units, not within the range of prescribed study, have come to my attention.

In the citation of specimens the following abbreviations are used: University of California, Berkeley (UC); Pomona College, Claremont, California (P); United States National Herbarium (US); State College, Pullman, Washington (WSC).

Arabis Hoffmanii (Munz) comb. nov. *A. maxima* Greene var. *Hoffmannii* Munz, Bull. So. Calif. Acad. Sci. 31: 3. 1932.

Coarse perennial; stems one to several from a deep woody and scaly caudex, branched above, entirely glabrous or very sparsely pubescent below, 5–7 dm. high; basal leaves numerous, crowded, linear-lanceolate, sinuate-dentate, obtuse, glabrous or nearly so above, pubescent with dendritic hairs below, coriaceous, 5–10 cm. long, 6–10 mm. wide, mid-rib wide and prominent, petiole broadly winged to the base; cauline leaves sessile, crowded linear-oblong, obtuse, auriculate and somewhat clasping, green and glabrous above, pubescent below, 3–6 cm. long, 4–6 mm. wide; sepals oblong, obtuse, green, glabrous or sparsely pubescent, 4–5 mm. long; petals linear-oblong, slightly narrowed toward the base, white, conspicuously midveined, 8–10 mm. long; fruiting raceme elongated (half the length of the stem); pedicels ascending, glabrous, 1–4 cm. long; pods erect-spreading, becoming slightly arcuate, glabrous, thick and coriaceous, nerveless, obtuse, 6–10 cm. long, 2–3.5 mm. wide, style short and stout; seeds orbicular, narrowly winged, 1 mm. broad, biserial.

While definitely related to *Arabis maxima* Greene, this unit is easily characterized as a specific entity. It differs from *A. maxima* in the following essentials: (1) coriaceous basal leaves which are green and glabrous above and possess a broadly winged petiole; (2) glabrous stems which are profusely branched above; (3) pedicels long, glabrous and ascending; (4) pods nerveless, thick and coriaceous; (5) seeds small, orbicular, narrowly winged and definitely biseriate.

California. Santa Cruz Island: without locality, April, 1888, *T. S. Brandegee* (UC); ledges in sea cliffs east of Dick's Harbor, February 28, 1932, *R. Hoffmann 653* (P, type of *A. maxima* var. *Hoffmanii* Munz); May 23, 1932, *R. Hoffmann*.

It will be noted that *Arabis Hoffmannii* is exclusively insular, inhabiting the sea cliffs, whereas *A. maxima* is continental and commonly collected at lower elevations in California. The hiatus in the ranges of these two units is a further evidence of specific delimitation.

Arabis Lemmonii Watson var. **depauperata** (Nelson and Kennedy) comb. nov. *A. depauperata* Nelson and Kennedy, Proc. Biol. Soc. Wash. 14: 35. 1906.

Stems numerous, filiform, simple or often branched above, stellate pubescent at least below, 8–20 cm. high, many of the stems sterile; basal leaves narrowly oblanceolate, finely and densely stellate pubescent, petiolate, 6–20 mm. long, 2–4 mm. wide; cauline leaves sessile, lanceolate, obtuse, pubescent or the uppermost glabrate, 4–10 mm. long; flowers small; sepals 2 mm. long; petals pink, 4–5 mm. long; pedicels pubescent; pods horizontal or erect-spreading, glabrous, fruiting raceme elongated (almost one-half the length of the stem).

PLATE XXI. ARABIS HOFFMANII (MUNZ) ROLLINS. Photograph of type (Pomona College Herbarium, no. 180269).

The variety *depauperata* differs from the species in having linear-oblanceolate basal leaves, pubescent lanceolate cauline leaves, and filiform pubescent branching stems; also the pods are usually ascending, whereas in *A. Lemmonii* the pods are either horizontal or somewhat pendulous.

Nevada. Washoe County: summit of Mount Rose, Aug. 17, 1906, *Kennedy 1167* (UC, isotype of *A. depauperata* Nelson and Kennedy); July 28, 1909, *Heller 9868* (US). California. Placer County: Tinkers Knob, July 18, 1897, *C. F. Sonne* (UC). Eldorado County: Mount Tallac, July, 1903, *Hall & Chandler* 4624 (UC). Lake Tahoe Region: top of Ellis Peak, July 13, 1923, *W. C. Blasdale* (UC).

Arabis rectissima Greene, Pittonia 4: 191. 1900. This species, heretofore almost unrecognized, has been found to be a valid and distinct specific unit. It has been collected from points in southern Oregon to Tulare County, California. The collections from California cited below will serve to show its distribution in that state.

California. Siskiyou County: Black Butte north of Sisson, June 23, 1916, *Heller 12421* (US, WSC). Plumas County: Prattville, July 11, 1907, *Heller & Kennedy 8809* (UC). Lake Tahoe Region: Rubicon Park, July 16–21, 1901, *Setchell & Dobie* (UC). Yosemite Creek and Indian Canyon to Porcupine Flat, Yosemite National Park, July, 1902, *Hall & Babcock 3481* (UC); Indian Creek, July 20, 1911, *Hall 9177* (UC); Inspiration Rock, 1860–67, *Bolander 4904* (UC). Fresno County: Dinkey Creek, June 25, 1900, *Hall & Chandler 346* (UC). Tulare County: Sequoia National Park, June, 1896, *Purpus 1797* (UC); Olancha Mountain, June 25–30, 1904, *Hall & Babcock 5290* (UC).

State College of Washington,
Pullman, March 9, 1936.

VARIETIES OF THE DESERT WILLOW, CHILOPSIS LINEARIS

F. Raymond Fosberg

In the course of determining my collections from the Mesilla Valley of the Rio Grande, in New Mexico, I noticed that the material of *Chilopsis* differed from the common form, known as *Chilopsis linearis* in the deserts of California. The New Mexican plants had the leaves erect and very strongly glutinous. The Index Kewensis gave the name *Chilopsis glutinosa* Engelm. which I looked up in the Botany of Wislizenus Expedition. Engelmann here mentions two forms, "one from the neighborhood of Saltillo with larger, paler flowers, broader, not glutinous leaves, and woolly branchlets, perhaps the *Ch. saligna* Don; the other from New Mexico and Chihuahua with longer, narrower glutinous leaves, perfectly glabrous, glutinous branchlets and darker and

smaller flowers, may be *Ch. linearis* DC., or a new species, *Ch. glutinosa.*"

Chilopsis glutinosa has been very generally ignored since this somewhat doubtful publication. Wooton and Standley, in the Flora of New Mexico, do not even include it in the synonymy of *Chilopsis linearis.* The names *Chilopsis linearis* (Cav.) Sweet and *Chilopsis saligna* D. Don have been used more or less interchangeably for the plants from the whole range of the genus, with the majority of botanists using *C. linearis,* as it has priority. Neither of the two forms described by Engelmann corresponds well with the common California plant, with its glabrous, non-glutinous branchlets and strongly arcuate, narrow leaves. Checking up the original descriptions of both *Chilopsis linearis* and *C. saligna,* I found that they both apply to a plant with straight, linear-lanceolate leaves. No mention is made in either description of whether or not the leaves and branchlets are glutinous. According to description the branches of *C. linearis* are fuscous, but no mention is made as to whether they are glabrous or pubescent. The branchlets of *C. saligna* are described as pubescent. It is obvious from the plates and descriptions that both of these names apply to the same plant and that the plant described is the form found from central to southern Texas. This is the only one with pubescent branchlets and straight leaves as wide as those illustrated by Cavanille. It is also evident that this is the plant which Engelmann had from Saltillo. Thus the name *Chilopsis saligna* D. Don is an exact synonym of *Chilopsis linearis* (Cav.) Sweet.

Engelmann's description fits the plants which I collected in southern New Mexico very well. Unfortunately these specimens were accidentally lost or destroyed. An examination of the material of this genus in the herbaria of the University of California, the California Academy of Sciences, Pomona College, the Los Angeles Museum, and of Mr. Joseph A. Ewan brought to light a number of other collections of this form. The western form of this plant is different from either of the two from farther east in that the branchlets are glabrous or nearly so; the leaves not at all glutinous or rarely very slightly so, and strongly arcuate, standing out from the stem and bending down in a wide curve. Field study reveals that the color difference noted in the flower by Engelmann is not characteristic of the two plants discussed by him, but that there are two color phases in at least the western and the New Mexican forms. Plants with pale pink flowers with lavender and yellow markings are found growing side by side in the Mesilla Valley with similar plants having dark purple flowers with white markings. Both of these color phases have been noted in the western form, but not growing side by side. Whether or not there is a dark form of the Texas plant I do not know, as I have not seen it growing. Size of the flowers, size and form of the calyx, and woolliness of the calyx

and inflorescence vary so much that they are of no value whatever in separating these plants. Collections with perfectly glabrous inflorescences come from scattered localities over the whole range of at least the western form, and from exactly the same localities that very woolly and slightly woolly ones come.

It seems proper to separate these three plants as varieties, as their differences are scarcely sufficient to merit specific rank, and there are intergrading forms. They have fairly definite geographic ranges, and they are rather different in aspect. Not much is known about the extension of their ranges into Mexico.

I take pleasure in thanking those in charge of the above mentioned herbaria for the privilege of examining the material of this genus in their collections.

The genus *Chilopsis* D. Don, in the family Bignoniaceae, contains, as far as is known, only one species, *Chilopsis linearis*. The following description of this species will serve for a generic description as well.

Chilopsis linearis (Cav.) Sweet, Hort. Brit. ed. 1: 283. 1827.

Shrub or small tree, up to 4–5 m. tall, spreading, branchlets slender, wandlike; leaves alternate, simple, linear to lanceolate, narrowed at base but without a very distinct petiole; inflorescence a terminal raceme, usually coarsely woolly, each pedicel subtended by a linear bract somewhat longer than the pedicel, pedicels up to 1 cm. long; calyx glabrous to densely woolly, over 1 cm. long, broadly ovoid, bilabiate, the upper lobe 3 toothed, the lower 2 toothed, the teeth small, triangular; corolla funnelform-campanulate, the tube little exceeding the calyx, the throat about 1.5 cm. long, somewhat at an angle to the tube, the limb flaring, 5 lobed, the lobes erose, about 1 cm. long, rounded, the whole zygomorphic, the lower side somewhat flattened, with 2 longitudinal folds, these folds villous inside; stamens 4, attached near the top of the tube, the two longer 1.5 cm. long, the two shorter about 1.2 cm. long, the anthers with 2 oblong-ovate cells, at maturity diverging 180 degrees from each other, dehiscent by a slit on the ventral surface the full length of the cell, opening out wide; pistil about 2.5 cm. long, the ovary narrowly cylindrical, about .6 cm. long, the stigma spatulate, becoming 1–1.5 mm. wide, somewhat split into two thin plates at the apex; fruit a linear terete 2-celled capsule up to 3 dm. long; seeds about 8 mm. long, 2–3 mm. wide, oblong, flat, thin, with obtusely pointed ends, bearing a coma 1–1.5 cm. long at each end, attached in the middle, the hilum a transverse linear scar across one side, showing through to the other surface of the thin seed.

Range: California, eastern half of Mojave Desert, also Colorado Desert; south into Baja California; east to southern Nevada, Arizona, New Mexico, Texas; south to Sonora, Chihuahua, Durango, Zacatecas and Tamaulipas, Mexico.

KEY TO THE VARIETIES

Sterile branchlets somewhat woolly, veins in leaves prominent .... *C. linearis* var. *originaria*

Sterile branchlets glabrous or almost so, veins in leaves not usually prominent.

Sterile branchlets and young leaves glutinous .... *C. linearis* var. *glutinosa*

Sterile branchlets and young leaves not glutinous ..... *C. linearis* var. *arcuata*

CHILOPSIS LINEARIS var. **originaria** Fosberg, nom. nov. *Chilopsis linearis* (Cav.) Sweet, Hort. Brit. ed. 1, 283. 1827. *Bignonia ? linearis* Cav., Icon. Pl. 3: 35, t. 269. 1794. *Chilopsis saligna* D. Don, Edinb. Phil. Journ. 9: no. 18, 261. 1823.

Sterile branchlets more or less woolly, not glutinous; leaves straight, linear-lanceolate, tending to diverge from the branch, heavily and conspicuously veined.

Range. Texas, eastern New Mexico, south into Mexico for an unknown distance; intergrading with *C. linearis* var. *glutinosa* in New Mexico, southeastern Texas and Mexico.

Specimens seen. TEXAS. Bexar County: San Antonio, *Mr. & Mrs. Clemens 859, 860, 861.* Jeff Davis County: Little Ajuga Canyon, Davis Mts., *Moore & Steyermark 3154.* NEW MEXICO. Chavez County: 35 miles south of Roswell, *Earle & Earl 369.* Grant County: Mangas Springs, 18 miles northwest of Silver City, *Metcalfe 207.* MEXICO. Est. Zacatecas (norte): Hacienda de Cedros, *Lloyd 154.* Specimens intergrading with *C. linearis* var. *glutinosa.* TEXAS. Laguna, *Munz 1281* (like the variety *glutinosa,* but with twigs slightly hairy). MEXICO. Santiago Papasquiaro, Durango, *Palmer 421* (with narrow leaves, practically glabrous branchlets and very prominent veins); Santa Eulalia Hills, Chihuahua, 1885, *Wilkinson* (like the variety *originaria,* but with glabrous, somewhat glutinous branchlets).

CHILOPSIS LINEARIS var. **glutinosa** (Engelmann) Fosberg, comb. nov. *Chilopsis glutinosa* Engelmann, Bot. Wisliz. Exped. 44–45. 1848.

Sterile branchlets glabrous, glutinous; leaves linear, tending to be erect, straight or somewhat arcuate, glutinous, especially when young; calyx not as woolly as in var. *originaria,* in certain collections (*Wright,* Oct., 1849; *Palmer 390*) glabrous or practically so.

Range. New Mexico and southwestern Texas, particularly near the Rio Grande, south for an unknown distance into Mexico, intergrading with the variety *originaria* on the east and south, and with the variety *arcuata* in Arizona.

Specimens seen. TEXAS. "Western Texas to El Paso," Oct., 1849, *Wright 428.* Canutillo, July 12, 1911, *Barlow.* Brewster County: Chisos Mts., *Moore & Steyermark 3264.* NEW MEXICO. Along the Rio Grande, *Rusby 333.* Sierra County: Berendo

Creek, *Metcalfe 894*. Dona Ana County: Jornada Range Reserve, 25 miles north of Las Cruces, *Ellison 718;* near Las Cruces, June 4, 1893, June 8, 1906, *Wooton & Wooton 66*. Hidalgo County: 17 miles south of Animas, Animas Valley, *Wolf 2590* (like *C. linearis* var. *arcuata,* but the young growth somewhat glutinous). MEXICO. Vicinity of Victoria, Tamaulipas, alt. 320 m., *Palmer 390*.

CHILOPSIS LINEARIS var. **arcuata** Fosberg, var. nov.

Ramuli glabri vel paullo puberuli, non glutinosi; folia linearia arcuata.

Range. Eastern half of the Mojave Desert, California, south through the Colorado Desert to Baja California, east to southern Nevada, Arizona, western New Mexico, south to Sonora, Mexico, intergrading in New Mexico with *C. linearis* var. *glutinosa*.

Specimens seen. CALIFORNIA. San Bernardino County: Mission Creek, e. San Bernardino Mts., alt. 1000 m., *Fosberg 8600* (type collection; type in Herb. U. C.); wash north of Lucerne Valley, Mojave Desert, *Fosberg 8576;* Daggett, Oct. 2, 1924, *Jones;* Cushenberry Springs, Aug. 31 and Sept. 1, 1924, *Abrams 2412* and *Johnston;* San Mateo Canyon, June, 1883, *S. B. & W. F. Parish*. Riverside County: Banning, June 14, 1921, *Jaeger,* May 28, 1928, *Van Dyke;* Whitewater, Oct. 2, 1924, *Jones;* Palm Springs, *Spencer 800, Schellenger 32, G. B. Grant 170a–6740;* Dripping Springs, near Temecula, July 13, 1900, *Jones;* Aguanga, *Munz & Harwood 7304*. San Diego County: San Felipe, *Palmer 291, Abrams 3979,* and June 23, 1932, *Epling, Darsie, Knox & Robinson;* Cane Brakes Canyon (eastern San Diego County) *Fosberg 8429;* Jacumba, Aug. 7, 1886, *Orcutt*. Imperial County: Carriso Gorge, *Parks 01093*. NEVADA. Lincoln County: Mormon Mts., *Kennedy & Gooding 138*. Sheep Mts., *Purpus 6133*. ARIZONA. Mohave County: Union Pass, Kingman, May 3, 1893, *Wilson 26,* May 31, 1893, *Wilson*. Yavapai County: Kirkland Creek, Wickenburg, *Gillespie 8506;* Bumblebee, *Gillespie 8712*. Maricopa County: Phoenix, *Nelson 10283* (calyx woolly), *Nelson 10290* (calyx glabrous); Tempe, Sept. 5, 1901, *Thornber*. Pima County: Tuscon, July 15, 1895, *Toumey;* Tucson, 1920, *Spencer 284*. Cochise County: Lowell, May 31–July 27, 1881, *Pringle;* Lowell, *Thornber 51*. Sabino Canyon, Santa Catalina Mts., *Shreve 5203*. Douglas, May 28, 1907, *Gooding 2316,* Chiricahua Mts., July 22, 1907, *Gooding 2316* (two collections under this number). Pino Blanco Spring, Tumacacori Mts., *Hilend 770*. Santa Rita Mts., Nov. 1891, *Brandegee*. NEW MEXICO. Rincon, Aug. 27, 1903, *Diehl*. MEXICO. Baja California: Calamujuet, May 10, 1889, *Brandegee;* San Pedro Martir, *Robertson 40, 41*. Sonora: El Alamo, w. Magdalena, *Kennedy 7042*.

University of Hawaii, Honolulu,
November 12, 1935.

A NEW EQUISETUM

E. B. Copeland

Equisetum fontinale Copel. sp. nov. Equisetum, *E. hiemali* remote affine, rhizomate nigrofusco, glabro, molle; caulibus annuis, caespitosis vel basi ima ramosis, alibi ramis omnino carentibus, usque ad 40 cm. altis et 3.5 mm. crassis et 15-striatis, plerisque ca. 25 cm. altis vix 2 mm. crassis et 7–9–striatis, tactu mollibus sub lente asperulis, rosulis minutis transversaliter ordinatis ornatis, carinis angustis vix angulatis et haud concavis, valleculis latis non profundis, lacuna axiale maxima, vaginis fere cylindraceis appressis concoloribus, carinis sursum sulcatis sulcis in baseos dentium desinientibus, dentibus lanceolatis vaginarum supremae campanulatae et basalium persistentibus alibi caducis albomarginatis, basibus persistentibus punctis nigris interdum sursumcurrentibus ornatis; stomatibus utroque latere valleculae quaeque uniseriatis, sub foramine irregulariter rotundo immersis, radiis ca. 12 prope aperturam rectis, remotius rarius furcatis; spica 1–1.3 mm. longa, pedicello denique 3 mm. longo sustensa, apice aut obtusa aut breviapiculata; sporis elateribus praeditis.

Fig. 1. *Equisetum fontinale* Copel. Spikes from type specimen showing rounded and pointed apices.

California: Butte County, on wet grassy hillside among springs sloping south toward Butte Creek, altitude 1510 m., June 24, 1930, *E. B. Copeland.* Exsiccatum: California Plants, ex Herb. Univ. Calif., no. 403. Type in Herb. Univ. Calif., no. 426895. (Pl. XXII.)

Grouping the species according to Milde, primarily according to the distribution, disposition and structure of the stomata, this falls unmistakably in his subgenus (or genus) *Hippochaete;* the only deviation from the typical stoma of this group is in the number of thickened lines on the outer wall of the guard cell,—about twelve in *E. fontinale,* sixteen or more, ac-

PLATE XXII. EQUISETUM FONTINALE COPEL. Photograph of type (University of California Herbarium, no. 426895).

cording to Milde, in all other species. If the emphasis be placed on the tip of the spike, as in various recent treatments of the genus, the place of *E. fontinale* is uncertain; wherefore it appears that this feature has been given undue importance. Whether immature or mature spikes be examined, some will be found with rounded and some with pointed apices. The accompanying photograph shows two spikes on one plant of the type (fig. 1).

Following Milde's classification, *E. fontinale* falls in his "Equiseta monosticha," with the stomata in single rows; within that group, in *"Equiseta hiemalia,"* judging by the appressed sheaths. As to real affinity, however, it may not be nearer to *E. hiemale* than to *E. debile* or *E. variegatum*. *E. kansanum* Schaffner, as represented in our Herbarium, is a much larger and stouter plant, with relatively narrow grooves, and stout spikes with rounded apices.

University of California,
Berkeley, California,
January 7, 1936.

REVIEW

Green Laurels—The Lives and Achievements of the Great Naturalists. By Donald Culross Peattie. Pp. xxiii + 368, with 32 figures, mostly full-page portraits; bibliography; index. Simon and Schuster, New York, 1936. $3.75.

In this book a mind capable of enthusiasm and a skilled pen have disclosed, from a matrix of extensive and accurate knowledge, a series of brilliant personalities. The temptation to compare these biographies with the brilliant work of De Kruif is inescapable. The "microbe hunters" were drawn from a limited field of science and an intensely practical one; and the enthusiasm of the author who celebrates them is earthly, without a trace of poetry. Peattie draws from a wider field, and understands the abnegation of the directly applicable; he thrills to the trees and birds and insects which he sees in Illinois; he can see and make us see the forests of other times and places, and the weird landscapes of Lapland and the Galapagos. This seems the best possible way of introducing to folk in general the explorers of nature.

I cannot know whether the general public will find this work thrilling. It is the elementary student, suffering from the information that "Janssen (or was it Zanssen?) invented the compound microscope in 1590; Hooke discovered the cell in 1665; Malpighi and Grew founded plant anatomy in . . . " who will find the most exhilarating relief.

The professor, true to his training, will look for flaws and find them. Poetical enthusiasm arouses his distrust. In the introduction, a distinction is drawn between field men and laboratory men. This is a real distinction; but to restrict the terms

"naturalist" and "biologist" respectively to the former and the latter seems unsound. Again, in referring to Lamarck, it is enough credit to him that he propounded the theory of evolution. It is perhaps true that the subsidiary theory of the inheritance of acquired characters is not dead: but if my mind rejects it, I cannot think the author does well in seeming to accept it. Incidentally, I despise the terms "Lamarckism" and "Darwinism." They have been used too often without precise definition and in manners derogatory to Lamarck and Darwin. Finally, in the description of the Galapagos, there is a passage which might be taken to imply that marine mammals are primitive. These are among the professor's possible objections: but an interest in men may survive in a specialist in Melanconiales; any device will be welcome to one who thinks young people should know of Linnaeus; and the professor will recommend the book to his students and see that it is available.

The biographies presented are selected primarily by personal appeal. Some who appear are great in every sense, and simple withal, as Linnaeus and Darwin. Bartram and Fabre are unassuming but incapable of remaining unknown. The eminently respectable have sometimes to be admitted, but appeal less; such are Buffon and Goethe. One man forces himself in against distinct personal dislike. A mere minister of state who stood toward Lamarck as Cuvier did might have been passed over with contemptuous mention; but Cuvier was also a validly eminent scientist. Most appealing of all are the pathetic, the unrecognized men of genius, Lamarck, Michaux, the absurd Rafinesque, the embittered Wilson. As a man of broad knowledge, the author cannot help sometimes inserting mere catalogues of names; it is perhaps necessary, in connection with a life of Michaux, that Pursh and Nuttall be mentioned; but their names tend to be distracting. Even the unnamed, the drearily plodding mounters in herbaria, are remembered.—H. F. C.

NOTES AND NEWS

Essays in Geobotany in honor of William Albert Setchell has recently appeared as a publication of the University of California Press. The volume, "honoring one who has contributed much to the advancement of his science and to the life of the University in which he has served for more than forty years," is edited by Thomas Harper Goodspeed. A biographical sketch of Dr. Setchell by T. H. Goodspeed introduces the volume. The frontispiece is a portrait of Dr. Setchell by Peter Van Valkenburgh. The book contains 319 pages and consists of the following essays: the rate of plant migration, by O. W. Arrhenius; the origin of *Crepis* and related genera, with particular reference to distribution and chromosome relationships, by E. B. Babcock; the succession and distribution of Cenozoic floras around the

northern Pacific Basin, by R. W. Chaney; the origin of desert climax and climate, by F. E. Clements; the strand and dune flora of the Pacific Coast of North America: a geographic study, by W. S. Cooper; the genetic phytogeography of the southwestern Pacific area, with particular reference to Australia, by Ludwig Diels; the rôle of the terrestrial Alga in nature, by E. E. Fritsch; the plant as a metabolic unit in the soil-plant system, by D. R. Hoagland; Malaysian phytogeography in relation to the Polynesian flora, by E. D. Merrill; plant communities of the world, by Eduard Rübel; antarctic plants in Polynesia, by Carl Skottsberg. A bibliography of the published writings of William Albert Setchell (to the present year) closes the volume.

Dr. Gunnar Hiorth of the College of Agriculture, Aas, Norway, spent most of the summer in California, Oregon, and Washington, collecting seeds of the different natural strains of *Godetia amoena* and its near relatives. Dr. Hiorth is studying the genetics of this species and the nearest related forms. Having found only a small portion of the numerous existing races of *Godetia amoena,* he would be very grateful if any botanist who finds interesting strains of this species would send seed to him (address: Landbrukshöiskolen i Aas, Norway). Since different races of this species often occupy closely adjacent regions, the locality from which the seed is gathered should be stated as exactly as possible. Dr. Hiorth states that there is a much greater range of color in the flowers of the wild populations, as they occur on the Pacific Coast, than there is in those of the cultivated races. Regarding the question of whether *Godetia amoena,* as commonly understood, is not in reality composed of a number of species he inclines to the view that this group is actively differentiating into numerous distinct races or even species.—D. Keck.

Two new parts of volume two of "A Flora of California" by Willis Linn Jepson (published by the Associated Students' Store, University of California, Berkeley) have recently appeared. Part two, issued February 20, 1936, comprises pages 17–176 and figures 128–162. It includes the following families: Cruciferae, Sarraceniaceae, Droseraceae, Crassulaceae, Saxifragaceae, Crossosomataceae, and Rosaceae (in part). Part three, issued July 20, 1936, comprises pages 177–336 and figures 163–206. Rosaceae (in part) and Leguminosae (in part) are included. Price of each part $1.50.

Dr. Harry Borthwick, Dr. Alfred Clark, and Dr. Samuel Emsweller of the College of Agriculture, University of California, and Dr. John MacKay of the Department of Botany, Utah State Agricultural College, have accepted positions with the United States Department of Agriculture. They will be stationed at the Horticultural Field Station, Beltsville, Maryland, and will carry on research with various nut crops.

Dr. Henry Northern upon whom was conferred the degree of Doctor of Philosophy, May, 1936, at the University of California, Berkeley, has accepted the position of Assistant Professor of Botany at the University of Wyoming.

On July 1, 1936, Dr. A. R. Davis, Professor of Plant Physiology, University of California, Berkeley, succeeded Professor D. R. Hoagland as chairman of the Department of Botany. Professor Hoagland resigned in order that he might devote more time to his duties as chairman of the University Budget Committee and to his enlarged activities as chairman of the Division of Plant Nutrition of the College of Agriculture.

Dr. Harold St. John, University of Hawaii, who has spent his sabbatical year in Europe and the United States (proper), has returned to Honolulu. During August, Dr. St. John spent two weeks at Pullman, Washington, completing his flora of the Palouse region of southeastern Washington.

Professor H. E. McMinn of Mills College, California, served in the capacity of Professor of Botany for the "Traveling University" this summer. The course, "North American Trees," was given under the auspices of Mills College. The following important stops were made for field work and study: Dallas, Texas; New Orleans; Blue Ridge Mountains of Virginia; New York Botanical Garden; Arnold Arboretum; New England states, especially New Hampshire and Vermont; the region in the vicinity of Quebec; Chicago. The tour ended August 19.

Through the pages of Science, we learn that the Herbarium of the University of Oregon has been incorporated into a Museum of Natural History which includes also three other natural science collections, the Condon Museum of Geology, the Oregon State Museum of Anthropology, and the Oregon State Museum of Zoology. The Museum will have one administrative officer, Dr. L. S. Cressman, and will operate under one budget, but each unit will retain its identity and have its own curator.

Dr. Frans Verdoorn of Leiden, Netherlands, arrived in the United States during the latter part of July, 1936. He is visiting various botanical institutions in the interests of "Chronica Botanica" as well as in connection with his researches on Hepaticae. Early in September, he spent a few days at Stanford University and at the University of California, Berkeley.

Dr. K. Togashi, Professor of Plant Pathology, who is on a two years' leave of absence from Morioka Imperial College of Agriculture and Forestry, Morioka, Japan, has spent some time collecting parasitic fungi in various parts of California and

carrying on research at the University of California Herbarium. Dr. Togashi expects to remain in Berkeley until the middle of October.

After a summer of field work on the Fort Union formation of the Dakotas, Wyoming, and Montana, Dr. R. W. Brown spent the last two weeks of September in Berkeley, California. Dr. Brown is geologist of the United States Geological Survey and paleobotanist in charge of the Smithsonian Institution collection of mesozoic and cenozoic plants.

Dr. H. E. Stork, Professor of Botany, Carleton College, Northfield, Minnesota, is spending his sabbatical year in Berkeley. While here, he is continuing research on tropical woods.

Dr. W. A. Setchell, Professor of Botany, Emeritus, University of California, Berkeley, left on August 5, 1936, for a two months' sojourn in Europe. Dr. Setchell will spend some time at Kew and other botanical institutions.

Dr. George J. Peirce, Professor of Plant Physiology, Emeritus, Stanford University, and Mrs. Peirce, left July 20, 1936, for Europe. They expect to return in December.

George Neville Jones of the Department of Botany, University of Washington, Seattle, made a trip to Alaska this summer to further his studies on the northen flora.

PROCEEDINGS OF THE CALIFORNIA BOTANICAL SOCIETY

Thursday, January 30, 1936. A meeting was held in Room 2093, Life Sciences Building, University of California, Berkeley, California, 8:00 P. M. Dr. George J. Peirce, President, occupied the chair. The officers nominated at the previous meeting were elected unanimously. The following amendment was proposed by Dr. David D. Keck, acting for the Council: add to Art. IV, Sec. 2: Any member who pays an annual fee of twenty-five dollars, shall be designated as a "Sustaining Member" and shall have equal rights and powers with each Active Member. The amendment was unanimously approved at the meeting. According to the provisions of the constitution it was subsequently submitted to the entire membership for approval. At the date of writing (August 28, 1936) fifty-seven votes, all in favor of the amendment have been received. The business meeting was followed by a lecture by Professor E. B. Babcock, Division of Genetics, College of Agriculture, University of California, Berkeley, on "Cytogenetics as an Aid in Formulating Taxonomic Concepts." As pointed out by Professor Babcock, studies in the

genus *Crepis* indicate that primitive, diploid species are likely to be restricted in distribution or narrowly endemic, while related polyploid forms are widely distributed. A greater adaptability apparently often accompanies the polyploid condition. About fifty members and guests attended the meeting.

Saturday, February 29, 1936. The annual dinner of the California Botanical Society was held at International House, Piedmont Avenue and Bancroft Way, at 6:00 P.M. The President, Dr. George J. Peirce, acted as toastmaster. Dr. Mason, responding to a toast, gave a short résumé of the progress of the journal during the past year. A musical program was presented by students of Mr. W. W. Carruth of the Department of Music, Mills College. Dr. Peirce then introduced the speaker of the evening, Dr. F. W. Foxworthy, Forest Research Officer, retired, of the Federated Malay States. The lecture, "A Botanist's First Impressions of Malay," was illustrated. Dr. Foxworthy in the rôle of guide introduced his auditors to this tropical region, summarizing for them the general features of the flora and describing in more detail the characteristics of the three main vegetational areas: the strand, the cut over lands, and the virgin forest.

Saturday, April 4, 1936. A meeting was held in Room 460, Physiology Building, Stanford University, at 8:00 P.M. Dr. James McMurphy of the Department of Botany, Stanford University, was introduced as speaker by President George J. Peirce. Dr. McMurphy gave an illustrated lecture on "The Ages of Live Oaks," presenting very significant data as to the relative ages of live oaks of different sizes and also evidence as to the probable maximum age attained by any individual.—E. Crum, Secretary.

ERRATA

Page 31, line 45; *omit* that.
Page 33, footnote 2; *for* Am. Journ. Bot. *read* Madroño.
Page 33–40, title, also throughout article; for *microphylla* read *aculeata.*
Page 36, footnote 4; *for* Am. Journ. Bot. *read* Madroño.
Page 54, line 33; *after* lilac, *interpolate* or white, veined or blotched with purple, or reddish violet.
Page 63, line 33; for *grandiflorum* read *purpurascens.*
Page 223, line 18; *omit* Institution.
Page 228; *transpose* line 5 to position between lines 8 and 9.
Page 245, line 48; *for* it *read* is.
Page 260, line 3; for *microphylla* read *minutifolia.*
Page 283, line 12; for PUBESCENS read **pubescens.**

INDEX TO VOLUME III

New scientific names, and page numbers of principal entries of species and varieties, are printed in bold-face type.